AN OBSEVATIONAL STUDY ON THE HUMAN ACETABULUM IN SOUTH INDIAN FETUSES AND ADULT POPULATION

Dissertation submitted in

Partial fulfillment of the regulations required for the award of

M.D. DEGREE

In

ANATOMY – BRANCH V

THE TAMIL NADU DR. M.G.R. MEDICAL UNIVERSITY

CHENNAI

April – 2016

AN OBSEVATIONAL STUDY ON THE HUMAN ACETABULUM IN SOUTH INDIAN FETUSES AND ADULT POPULATION

Dissertation submitted to

THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY CHENNAI

In partial fulfillments of the regulations

for the award of the degree of M.D. (Anatomy)

BRANCH –V

THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY

CHENNAI

APRIL – 2016.

CERTIFICATE

This is to certify that the dissertation "**AN OBSEVATIONAL STUDY ON THE HUMAN ACETABULUM IN SOUTH INDIAN FETUSES AND ADULT POPULATION"** is an original work done by **Dr. D. Mathivanan,** Post graduate student, Department of Anatomy, PSG Institute of Medical sciences and Research, Coimbatore, under my supervision and guidance.

Dr. M. Nirmaladevi.M.S.
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Dean,
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DECLARATION

I solemnly declare that this dissertation "**AN OBSEVATIONAL STUDY ON THE HUMAN ACETABULUM IN SOUTH INDIAN FETUSES AND ADULT POPULATION**" was done by me in the Department of Anatomy, PSG Institute of Medical sciences & Research, Coimbatore, under the guidance of **Dr. M. Nirmaladevi. M.S**, Associate Professor Department of Anatomy, PSG Institute of Medical Sciences & Research, Coimbatore.

This dissertation is submitted to the Tamil Nadu Dr. M. G. R Medical University, Chennai in partial fulfillment of the university regulations for the award of degree of M.D Anatomy – Branch V examinations to be held in April 2016.

Place: Coimbatore

Date:

Dr. D. Mathivanan

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Firstly, I extend my heartful gratitude to my **Mom and Dad** for supporting me through out my life morally.

I bow and dedicate solemnly this work to **Dr.M.Nirmaladevi M.S.**, my guide, who helped me with her precious academic inputs, waited throughout the process patiently , corrected me in each stage and simply, without her , the dissertation would not have been made possible.

I express my heartful thanks to my HOD, **Dr.M.Jamuna.M.S.**, who encouraged me with my work and supported my work with financial assistance from the Department.

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I thank all my department faculties , fellow postgraduates who helped and supported me throughout the journey.

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PSG Institute of Medical Sciences & Research
Institutional Human Ethics Committee

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To
Dr D Mathivanan
Postgraduate
Department of Anatomy
PSG IMS & R
Coimbatore

Ref: Project No. 14/157

Date: April 27, 2015

Dear Dr Mathivanan,

Institutional Human Ethics Committee, PSG IMS&R reviewed and discussed your applications dated 24.03.2015 and 08.04.2015 to renew and amend the study entitled "*An observational study on the morphological and morphometrical parameters of acetabulum in South Indian adult population*" during the IHEC review held on 17.04.2015.

The following documents were reviewed and approved:

1. Request for renewal dt. 08.04.2015
2. Status report of the study
3. Amendment reporting form dt. 24.03.2015
4. Revised Methodology

The following members of the Institutional Human Ethics Committee (IHEC) were present at the meeting held on 17.04.2015 at Research Conference Room, PSG IMS & R between 2.00 pm and 4.30 pm:

Sl. No.	Name of the Member of IHEC	Qualification	Area of Expertise	Gender	Affiliation to the Institution Yes/No	Present at the meeting Yes/No
1	Mrs Y Ashraf	MPT	Physiotherapy	Female	Yes	Yes
2	Dr. S. Bhuvaneshwari (Member-Secretary, IHEC)	MD	Clinical Pharmacology	Female	Yes	Yes
3	Mr Gowpathy Velappan	BA., BL	Legal Advisor	Male	No	Yes
4	Mr P Karuppuchamy	M Phil in PSW	Social Scientist	Male	Yes	Yes
5	Mrs G Malarvizhi	M Sc	Nursing	Female	Yes	No
6	Mr. R. Nandakumar (Vice-Chairperson, IHEC)	BA., BL	Legal Expert	Male	No	Yes
7	Dr. G. Rajendiran	DM	Clinician (Cardiology)	Male	Yes	No
8	Dr. V. Ramamurthy	Ph D	Biotechnology	Male	Yes	No

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9	Mrs P Rama	M Pharm	Non-Medical (Pharmacy)	Female	Yes	Yes
10	Dr. P. Sathyan (Chairperson, IHEC)	DO, DNB	Clinician (Ophthalmology)	Male	No	No
11	Dr. Seetha Panicker	MD	Clinician (Obstetrics & Gyanaecology)	Female	Yes	Yes
12	Dr. S. Shanthakumari	MD	Pathology, Ethicist	Female	Yes	Yes
13	Dr. Sudha Ramalingam (Alternate Member-Secretary, IHEC)	MD	Public Health, Epidemiology, Genetics, Ethicist	Female	Yes	Yes
14	Mrs. Swasthika Soundararaj	MBA	Lay person	Female	No	Yes
15	Dr. D. Vijaya	M Sc, Ph D	Basic Medical Sciences (Biochemistry)	Female	Yes	Yes

The Committee approves the following:

1. To modify the title of the study as *"An observational study on the Human Acetabulum in South Indian fetuses and adult population"*
2. To include 30 fetuses in the above study
3. Renewal of approval for one year (from 15.05.2015 to 14.05.2016)

The decision was arrived at through consensus. Neither PI nor any of proposed study team members were present during the decision making of the IHEC. The IHEC functions in accordance with the ICH-GCP/ICMR/Schedule Y guidelines. The approval is valid until one year from the date of sanction. You may make a written request for renewal / extension of the validity, along with the submission of status report as decided by the IHEC.

Following points must be noted:

4. IHEC should be informed of the date of initiation of the study
5. Status report of the study should be submitted to the IHEC every 12 months
6. PI and other investigators should co-operate fully with IHEC, who will monitor the trial from time to time
7. At the time of PI's retirement/intention to leave the institute, study responsibility should be transferred to a colleague after obtaining clearance from HOD, Status report, including accounts details should be submitted to IHEC and extramural sponsors
8. In case of any new information or any SAE, which could affect any study, must be informed to IHEC and sponsors. The PI should report SAEs occurred for IHEC approved studies within 7 days of the occurrence of the SAE. If the SAE is 'Death', the IHEC Secretariat will receive the SAE reporting form within 24 hours of the occurrence
9. In the event of any protocol amendments, IHEC must be informed and the amendments should be highlighted in clear terms as follows:
    a. The exact alteration/amendment should be specified and indicated where the amendment occurred in the original project. (Page no. Clause no. etc.)
    b. Alteration in the budgetary status should be clearly indicated and the revised budget form should be submitted
    c. If the amendments require a change in the consent form, the copy of revised Consent Form should be submitted to Ethics Committee for approval
    d. If the amendment demands a re-look at the toxicity or side effects to patients, the same should be

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documented

e. If there are any amendments in the trial design, these must be incorporated in the protocol, and other study documents. These revised documents should be submitted for approval of the IHEC and only then can they be implemented

f. Any deviation-Violation/waiver in the protocol must be informed to the IHEC within the stipulated period for review

10. Final report along with summary of findings and presentations/publications if any on closure of the study should be submitted to IHEC

Kindly note this approval is subject to ratification in the forthcoming full board review meeting of the IHEC.

Thanking You,

Yours Sincerely,

SECRETARY
PSG IMS&R
COIMBATORE-641004.
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Dr S Bhuvaneshwari
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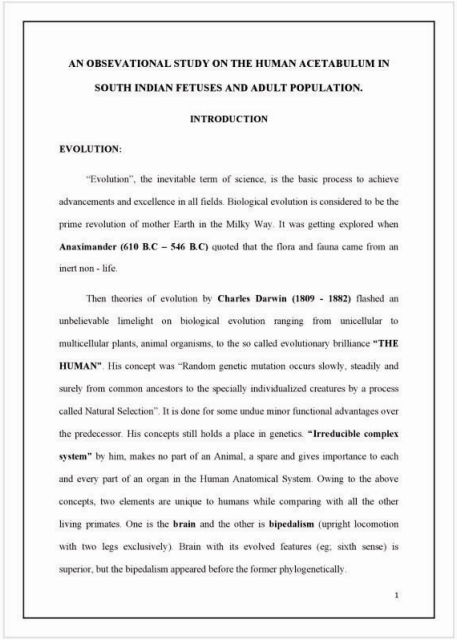

AN OBSEVATIONAL STUDY ON THE HUMAN ACETABULUM IN SOUTH INDIAN FETUSES AND ADULT POPULATION.

INTRODUCTION

EVOLUTION:

"Evolution", the inevitable term of science, is the basic process to achieve advancements and excellence in all fields. Biological evolution is considered to be the prime revolution of mother Earth in the Milky Way. It was getting explored when **Anaximander (610 B.C – 546 B.C)** quoted that the flora and fauna came from an inert non - life.

Then theories of evolution by **Charles Darwin (1809 - 1882)** flashed an unbelievable limelight on biological evolution ranging from unicellular to multicellular plants, animal organisms, to the so called evolutionary brilliance **"THE HUMAN"**. His concept was "Random genetic mutation occurs slowly, steadily and surely from common ancestors to the specially individualized creatures by a process called Natural Selection". It is done for some undue minor functional advantages over the predecessor. His concepts still holds a place in genetics. **"Irreducible complex system"** by him, makes no part of an Animal, a spare and gives importance to each and every part of an organ in the Human Anatomical System. Owing to the above concepts, two elements are unique to humans while comparing with all the other living primates. One is the **brain** and the other is **bipedalism** (upright locomotion with two legs exclusively). Brain with its evolved features (eg; sixth sense) is superior, but the bipedalism appeared before the former phylogenetically.

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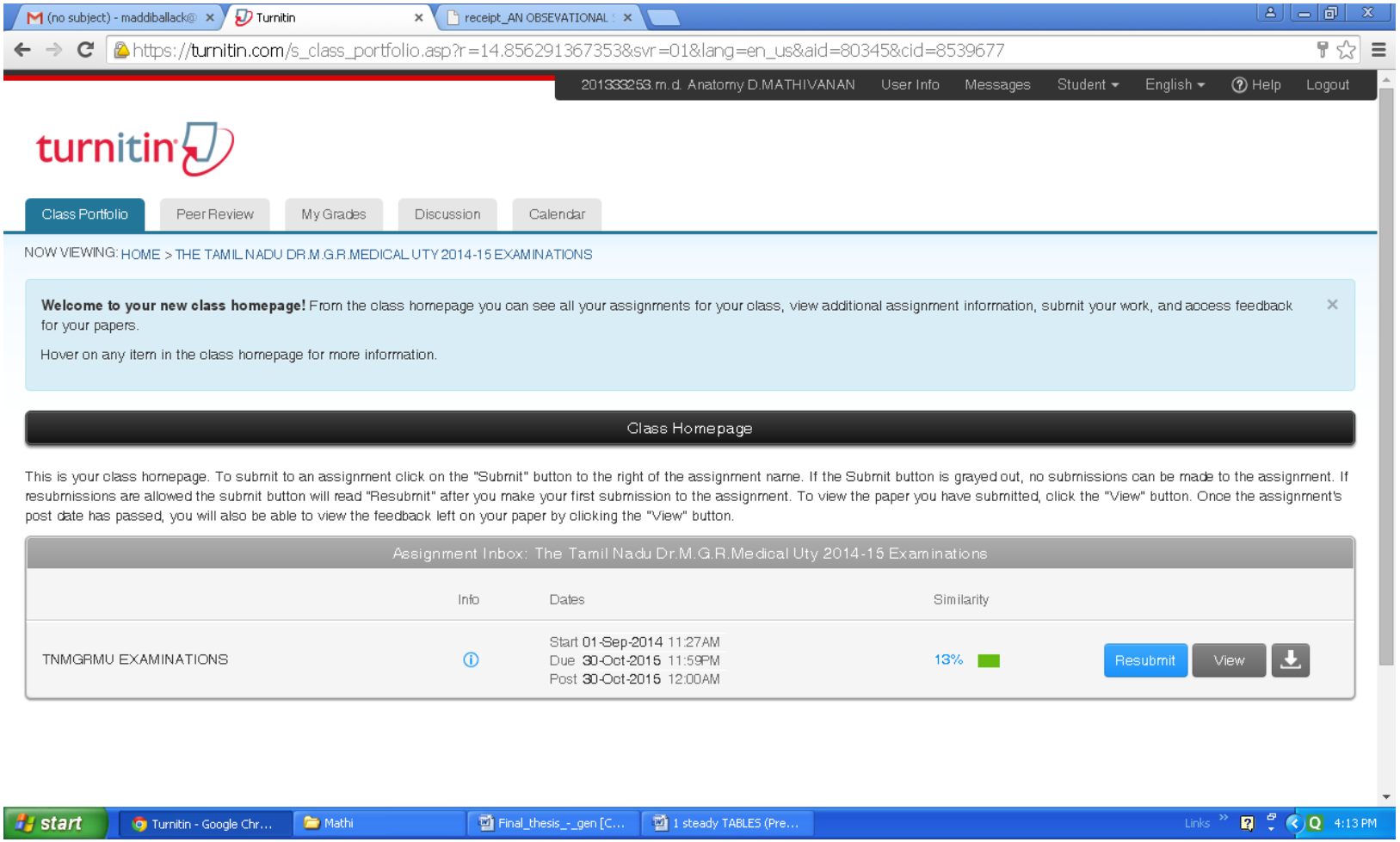
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TABLE OF CONTENTS

LIST OF ABBREVIATIONS

1.	**CE angle**	Centre Edge angle.
2.	**AD**	Acetabular Depth.
3.	**AA**	Acetabular Angle of Sharp.
4.	**ARO**	Acetabular Roof Obliquity.
5.	**AIA**	Acetabular Index Angle.
6.	**RA**	Roof Angle.
7.	**DTW**	Depth to Width ratio.
8.	**EI**	Extrusion Index.
9.	**LS**	Lateral Subluxation.
10.	**PED**	Peak to Edge Distance.
11.	**AV**	Acetabular Version.
12.	**JSW**	Joint Space Width.
13.	**AASA**	Anterior Acetabular Sector Angle.
14.	**PASA**	Posterior Acetabular Sector Angle.
15.	**GSN**	Greater Sciatic Notch.
16.	**IPR**	Ischio Pubic Ramus.
17.	**PAS**	Pre Auricular Sulcus.
18.	**V arc**	Ventral arc.
19.	**IPC**	Ischio Pubic Concavity.
20.	**CT**	Computed Tomography.
21.	**PACS**	Picture Archiving And Communicating System.
22.	**SPSS**	Statistical Package for Social Sciences.
23.	**Fig**	Figure.
24.	**min**	Minimum.
25.	**max**	Maximum.
26.	**S.D**	Standard Deviation.

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BIPEDALISM:

Paul Abell (Planetary small bodies' research scientist) in the year **1978,** at a place called Lateoli discovered the footprints, which was calculated to be about 3.6 million year old, belonging to **"Australopithecus afarensis"**. Then in the year **1980, White** described that the Homo erectus (Homo sapiens), which are considered to be the large brained on their evolutionary path, was evidenced in life only about 1.7 million years later than **"Australopithecus afarensis"**. Based on the "Theory of Natural Selection", the valgus angle in knee, fully adducted hallux, a complete foramen magnum are all eminent indicators of bipedalism but the most interesting changes for adaptation of bipedalism occurred in human pelvis for upright posture. So various anthropological studies have analyzed the pelvis of various species and documentations were made. Sacrum, ilium (anterior superior iliac spine), vertebral curvatures, the vertical alignment of sacroiliac joints with acetabulum and the acetabular features were analyzed exclusively to differentiate quadruped primate's pelvic Anatomy from the bipedals.

Human Anatomical Pelvic system as described in **Gray (2008)** is:

HUMAN PELVIS:

Human Pelvis (Cingulum membri pelvini) forms an important skeletal framework for both the abdominopelvic cavity and lower limb. The pelvic girdle is the example for irreducible complex system constituting two hip bones and sacrum. On a basis of strict evaluation, sacrum comes under vertebrae. Pelvic girdle not only transmits the weight from the femoral heads to the lumbar spine but also protects the

important visceral male and female pelvic organs and vital neuro vascular structures Knowledge on types of pelvis such as android, gynaecoid, platypelloid,anthropoid and various diameters of pelvic inlet, cavity and outlet such as transverse,antero posterior and oblique diameters are important during obstetrics and gynecological diagnostics and interventions.

HUMAN HIP BONE:

Hip bone (innominate bone) is a highly irregular bone present on both the sides, expanded above and below with a central constriction. The three parts of each hip bone are ilium, ischium and pubis. Anteriorly both the hip bones articulate with each other through pubic symphysis . The two hip bones articulates posteriorly in the midline with the sacrum (sacro iliac joint) thereby completing the pelvic girdle. The lateral surface of the hip bone has a deep cup called as acetabulum and it also has a oval or triangular foramen antero inferiorly called as obturator foramen. Anatomical knowledge on hip bone is essential on forensic (sex determination), orthopedics (fractures and surgical interventions) and anthropological grounds.The acetabulum articulates with respective femur on their side and forms a joint called Hip joint.

HUMAN HIP JOINT:

The hip joint (Articulatio coxae) is a synovial joint of ball and socket variety. It is a multi axial joint helping greatly in locomotion and weight bearing. The proximal articulating surface of the joint is the acetabulum (lunate surface) of the hip bone. The distal articulating surface is head of the femur.

HEAD OF THE FEMUR (HUMAN):

Head of the femur (thigh) is more than half a sphere, spheroidal in nature. It faces anterosupero medially to get articulated with the acetabulum. The center of the femoral head consists of fovea which gives attachment to the ligamentum teres. The head is intracapsular and it is encircled by the acetabular labrum.

HUMAN ACETABULUM:

Acetabulum **("acetum" - vinegar, "abulum" - saucer or cup)** literally **"a vinegar cup (in latin)"** also called as a cotyle (any cup shaped structure), is a bony component of hip bone or innominate bone. It is formed by the convergence of three parts of hip bone namely the ilium, the ischium and the pubis. The primary centre of hip bone appears for ilium, ischium and pubis which joins together to form the acetabulum.

GROSS ANATOMY OF ACETABULUM:

The acetabular opening is placed in such a way that it is facing obliquely forward, laterally and downward. The lateral cup shaped articular cartilage of acetabulum forms the surface for articulation, the Lunate surface. Centrally there is non articular fossa called as acetabular fossa (cotyloid fossa) with haversian pad of fat in the medial wall called as pulvinar. Acetabular notch is the deficient part on the inferior aspect of the acetabulum.Acetabular ridge is a bony crest that separates articular cartilage from the non articular fossa. It is present on inferior and posterior surface. Transverse acetabular ligament and acetabular labrum deepens the acetabular socket. Triradiate cartilage maintains the spherical congruency. The acetabular rim has

a complex shape with elevations and depressions; therefore the rim is not circular. The superior gluteal artery and inferior gluteal artery supplies the superior and inferior aspect of acetabulum respectively. The floor of the acetabulum is supplied by the artery to ligament of teres and the obturator artery supplies the pubic part of the hip bone.

EVOLUTIONARY BASIS OF ACETABULUM:

Millan MS et al (2015) stated that**,** understanding the biological diversity of a particular bone needs the comparison between various species, the shape and locomotion has a strong correlation which varies from species to species and human acetabulum, because of biped nature and loading environment, clearly stays distinct.

Canillas et al (2011), from various anthropological studies evidenced that the acetabulum had undergone various bony and soft tissue adaptive changes in the cycle of evolution. **(Table 1)**

HISTO - EMBRYOLOGICAL BASIS OF ACETABULUM:

Delaere et al (1999) observed that during the embryonic period, acetabulum and proximal femur arise from the single mesenchymal mass and after which they evolve as a blastemic tissue, precartilage and cartilage. Acetabulum becomes visible apparently in 14 to 15 mm embryo. It appears as a cellular depression located proximally to the developing femur, which occurs after the sixth week of gestation. At eight weeks of gestation the fully formed hip joint with all its elements like acetabular labrum, round ligament of femur etc. It is a shallow cavity in embryonic life and forms an arc of 65 – 70 degrees.

Table 1 : Comparative Anatomy of acetabulum.

		BIRDS (eg: hen , quail)	**REPTILES** (eg: lizard)	**AMPHIBIAN** (eg: frog, xenopus)	**MAMMALS** (eg:Rabbit, sheep and horse)	**MAMMALS** (eg:macaque, **HUMAN**)
S.NO	**BONE TISSUE**					
1.	Acetabular shape	Circular	Oval	Oval	Circular	Circular
2.	Acetabular fossa	Present	Absent	Absent	Present	Present
3.	Ischiopubic ramus	Absent	Absent	Absent	Present	Present
	SOFT TISSUE					
4.	Acetabular labrum	Absent	Present	Present	Present	Present
5.	Round ligament	Present	Depiction seen	Depiction seen	Present	Present
6.	Transverse acetabular ligament	Present	Depiction seen	Depiction seen	Present	Present
7.	Pulvinar	Present	Absent	Absent	Present	Present
8.	Meniscoid(M) meniscus (m)	Absent	Absent	meniscus (m) present.	Absent	Meniscoid (M)

During the foetal period the growth takes place, in which the ilium begins its ossification by the nineth week of gestation, ischium begins its ossification by the fourth month of gestation which is succeeded by the pubis after few weeks. This takes place by the skeletal blastomere development into cartilage which is a tri radiate cartilage and it forms a complete epiphysis of acetabulum. Chondrification starts and radiates from the joining of three primordie which is the antecedent for triradiatecartilage. Acetabulum develops from four types of cartilages. They are , the articular, undifferentiated hyaline cartilage, physeal cartilage and fibrocartilage of labrum. Acetabulum always lags behind femur in embryogenesis. Triradiate cartilage separates ilium,ischium and pubis.

Ralis et al (1973) stated that, from the initial point of acetabular development, the cavity of the acetabulum loses its stability, the gradient is in such a way that the depth to diameter ratio decreases there by making the cavity shallower during parturition. This natural phenomenon is to enhance the mobility of the hip joint during delivery and thereby indirectly compromising the stability.

In the newborn, the acetabular cartilage is separated from the triradiate cartilage by the small plate of woven bone, which signifies the first ossification area of acetabulum **.**Before puberty, the secondary ossification centers develop within the articular cartilage. The acetabular epiphysis and osacetabuli which are present in the ilium and pubis respectively representing the centres. Further growths of these centers are responsible for the increase in the depth of the acetabulum till the adolescence ends. These findings were observed by **Delaere et al (1999).**

In **Gray (2008)** it was explained that the complete fusion of acetabulum takes place between 16 to 18 years.

LIGAMENTS OF HIP JOINT:

Capsular ligament, Iliofemoral ligament, Pubofemoral ligament, Ischiofemoral ligament, Transverse acetabular ligament, Acetabular labrum, Ligamentum teres femoris(round ligament).

STABILITY OF THE HIP JOINT: Gray (2008).

The stability of the hip joint is provided by the following factors:

1) Acetabular depth and acetabular labrum support.
2) Iliofemoral, pubofemoral and ischio femoral ligaments strengthening the joint capsule.
3) Muscular support.(eg : gluteus maximus, gluteus minimus)
4) Obliquity and length of the neck of femur.

CLINICAL ANATOMY OF THE HIP JOINT:

1) Congenital dislocation of hip. 2) Dysplastic dislocation of hip. 3) Fracture dislocation of the joint.(Acquired dislocation) 4) Coxavara 5) Coxavalga	6) Osteoarthritis 7) Perthe's disease. 8) Cam impingement. 9) Pincer impingement. 10) Fracture neck of the femur

BACKGROUND FOR THE DISSERTATION

The reason for placing the Human Acetabulum as a dissertation topic , is to improvise the anatomical (morphological and mophometrical) knowledge of acetabulum extensively in a given population due to the following significances.

EVOLUTIONAL SIGNIFICANCE:

Anthropological studies reveal through the Human osteology that, morphology and morphometry of bones varies with different population due to varied geographical conditions and genetical traits. The assessment of the features of a particular bone (acetabulum) will help in diagnostics and interventions of the pathologies concerned with that bone , in that particular population. **Millan MS et al (2015),** on evolution basis, revealed that the adaptation of acetabulum is immense and quoted that "**Dinosaurs had perforated acetabulum whereas we have a well developed socket."**

SEX DETERMINATION: (FORENSIC ASPECT)

Nicholas Milne (1990) stressed the importance of acetabular diameter and depth in sexing of human hip bones.**Mukhopadhyay (2012)** analyzed the Acetabular diameter, which was taken as acetabular height.It is one of the components of Kelley's index which is used for human sex determination. The morphometric and morphological parameters of acetabulum in our race is to be documented which might serve as an aid for forensic analysis.

EMBRYOLOGICAL SIGNIFICANCE:

Embryological significance of the bony components has genetical backdrop. **Arsic S et al (2013)** in his study proposed that, prenatally and postnatally the shape of the acetabulum is altered due to pressure effects and a developmental disorder whereas **Eng JT** proposes out of her study in Mongolian population that routine work pressure does not alter the acetabular rim shape. So this has to be evaluated. **Walker JM (1981)** reported that 10% of congenital dislocation of hip is familial, with the incidence of one in thousand live births and he attributed the report towards the shallow acetabular cavity. Shallow acetabular cavity is called as dysplasia trait. Incidence is more common in girls and it is of left sided in nature. Walker study reveals that there is no sexual preponderance over congenital dislocation of hip and there is no significance of the same condition over the sidedness. Developmental dysplasia of hip (DDH) is to be evaluated and discussed with standard parameters for a given population. **Conybeare (2002), Price RP (2011)** and **Jin JG (2012)** imposed the importance of acetabular anteversion in children which plays a significant role in diagnosing DDH which may lead to premature arthritis.

GENETICAL SIGNIFICANCE:

Schoenecker J (2005) observed that the acetabular morphology in Down's syndrome (Trisomy 21) was altered in such a way that, greater degree of retroversion was seen and the posterior wall was deficient, which may lead to posterior dislocation of head of femur which is rare presentation.

ORTHOPEDIC DIAGNOSTIC AND SURGICAL SIGNIFICANCE:

DRY AND CADAVERIC ACETABULAR ASSESSMENTS:

The diameter of the acetabulum, the depth of the acetabulum and the capacity of the acetabulum are assessed during arthroplasty to design the acetabular cup implants. Two types of impingement are seen in hip joint (Femoroacetabular impingements), Cam and Pincer types. Variations in the anterior acetabular ridge morphology are the cause for pincer type of impingement as described by **Vyas K et al (2013)**, changes in femoral head causes cam type of impingement as stated by **Jessel (2000).** The lateral wall lip and the medial wall lip of the acetabulum serves as a predictor for the migration of acetabular cup post surgically and helps in the pre operative templating. The depth of the socket implies the grip of the joint which is considered important during the arthroplasty and assessed during pre operative templating. Ilioischial line (kohler's line) is measured and assessed for protrusion acetabuli.

DIAGNOSTIC AND INTERVENTIONAL SIGNIFICANCE IN RADIOLOGY:

Murray DW (1993) and **Nelitz M et al (1999)** observed that, in the advanced surgical (orthopedics), biomedical, Anatomical and Forensic fields, the radiological parameters were made as indicators and markers for diagnosis and interventions. Radiologically, Various angles eg: Acetabular version (AV) Centre edge angle (CE angle) of Wiberg , Acetabular index angle(AIA) or Tonnis angle ,acetabular angle of Sharp (AA), Anterior acetabular sector angle (AASA), Posterior acetabular sector angle (PASA), Roof angle (RA), acetabular roof obliquity(ARO) , indexes eg:

Extrusion index(EI), Joint space width(JSW),Acetabular depth (AD), depth to width ratio (DTW) and measurements like peak to edge distance (PED) , lateral subluxation(LS) are used to assess the X rays , computed tomograms (CT) of the acetabulum for diagnosing the pathology like acetabular dysplasia (a condition where the roof of the acetabulum becomes shallow and vertically oriented so that the space of the acetabular cavity allotted for articulation is getting reduced which leads to osteoarthritis) . AV, AASA and PASA are the parameters are helpful in pre templating during acetabular surgeries for assessing the acetabular coverage as described by **Delaunay et al (1997)**. The measurement of these parameters varies from population to population and the diagnostic range also varies from race to race.

Callaghan JJ (2007) stated that , during interventional surgical approaches of acetabulum like "ilio inguinal (anterior) by letournal , iliofemoral by smith and Petersen , posterior approach by Letournal and Judet, extended iliofemoral by letournal,tri radiate extensile approach Mears and Rubash and Carnesale extensile approach to the acetabulum", the radiological measurements proves mandatory for pre templating. Total hip arthroplasty, hemiarthroplasty are the advanced surgical interventions for functional impairment of hip joint for both young and old, for patients > 65 years of age with severe arthritis pain . It involves the assessment of acetabular depth, diameter, joint space width for pre operative radiographic evaluation of acetabulum in AP view of pelvis, CT and MRI scans. **Shapi et al's (2011)** .3D reconstruction with acetabular implant size recognition is the emerging technique during total hip arthroplasty which is having the acetabular diameter as a prime parameter. The evaluation was done on structural integrity,size of the acetabulum for

selecting the implant,the extent of reaming by **Alexander (1999),**to prevent prosthetic loosening, to resist ilio psoas impingement over the acetabular prosthesis and for doing the bone grafting. **Maslon et al (2013)** measured the Acetabular anteversion angle in aborted fetuses and showed that the acetabular orientation never changes significantly but it was the depth and the dimension of acetabulum which were responsible for hip joint malformations like congenital dislocation of hip. **Carlisle(2008)** stressed that the reliable measurement of radiological measurements are necessary because intra and inter observer variation is common when it comes to measurements.

Hence the evidence based precise assessment of acetabular parameters for both in adults and fetuses proves mandatory during diagnosis and interventions of acetabular based pathologies in orthopedics and pediatrics.

NEEDS FOR THE STUDY:

Based on the above applied background of acetabulum, the needs to study the acetabulum were:

ADULTS:

1) Anthropological studies reveal that there are ethnic difference in acetabular parameters between the asians and other races and within the Asians also there are documented variations. Inspite of this, extensive assessment was not done in India on acetabular morphometry and morphology especially in Radiological and aspects.

2) To use osseous, cadaveric and radiological aids (x rays , CT) to assess the morphology and morphometry of acetabulum in south Indian adult population which was not yet collectively tried in the south Indian population.

3) As combined study gives more evidence based information on acetabular measurements this study is carried out.

4) To set standardized acetabular parameters as Indian standard, comparable with International standards for pretemplating in surgeries like total hip arthroplasty, hemiarthroplasty, in diagnosis of common clinical conditions like osteoarthritis,protrusion acetabuli,congenital dislocation of hip,dysplastic dislocation of hip and also in forensic analysis.

FETUSES:

5) To assess the development of acetabulum in the fetuses(aborted) and to reveal the embryological significance of acetabular cavity with its morphology and morphometry in the south Indian population, which is yet to be documented precisely and since there is a existing debate on the significance of gender and sidedness nature of congenital dislocation of hip, there arose a need to monitor the sequence of changes in the acetabular cup morphology in both the sexes (males, females) and on both the sides(right, left).

AIM:

To study the morphological and morphometrical parameters of human acetabulum in adults using dry, cadaveric and radiographical assessments (X rays, CT) and in fetuses by cadaveric dissection.

OBJECTIVES:

1) To observe the results of various acetabular parameters in the dry, cadaveric and radiological approaches.

2) To enumerate the difference in the results of the parameters between males and females, right and left side in dry acetabula, cadaveric study and also in radiological approach..

3) To note on the sexual differences of human acetabulum in dry bones for assessing the gender.

4) To assess the difference in the morphometry and morphology of acetabulum with respect to the age of the foetus.

5) To document the difference in the morphometry and morphology of acetabulum in male and female fetuses with their right and left sides, belonging to the south Indian population.

6) To observe the variations in the results of various parameters in study group from the previous studies conducted in other population and to suggest and stress the clinical significance of the acetabular parameters both in fetuses and adults.

REVIEW OF LITERATURE

A) DRY ACETABULUM ASSESSMENT:

SEX DETERMINATION:

i) "Widening of greater sciatic notch starts from the posterior part and it is more significant in females" was explained by Singh **S (1978)** after examining the 120 males and 80 females' hip bones. He proved his hypothesis by documenting the mean angles of Greater sciatic notch in males right , males left , females right and females left as 65.31±7.53°, 66.15 ± 6.54°, 82.76 ± 8.44° and 83.66 ± 7.59° respectvely.

ii) In **Faruqi 2000 & Gray 2008** it was stated that:

Each hip bone is labeled as a male if the Iliac crest was observed to have more medial inclination and more ruggedness, ischial spine being more inverted, ischiopubic ramus being rough and everted and the muscular markings being more prominent.Each hip bone is labeled as a female if the Iliac crest was observed to being less curved and less rugged , ischial spine being not inverted , ischiopubic ramus being smooth and not everted and the muscular markings being less prominent.

iii) Greater sciatic notch grading by **Buiskstra, Ubelaker(2013)** states that acutely angled grade 1 accounts to male and increasing order of obtuse margin from grade 2 to grade 5 will be a female hip bone. The accuracy is 91 %. Presence of well demarcated pre auricular sulcus with more pits indicates that the observed hip bone is a female, poor demarcation of pre auricular sulcus with absence of pits indicates male hip bone. This method relatively has less accuracy when compared with above markers.

iv) "Traits of Phenice":

Three traits of hip bones have been grouped as phenice traits. They are

1) Ventral arc of pubis which is a slightly elevated ridge running laterally and inferiorly over the ventral surface of pubis and joining the medial border.
2) Nature of Ischiopubic ramus on the medial aspect when viewed vertically from the pubic Symphysis, there should be a prominent ridge present.
3) Prominent Ischio pubic concavity.

Presence of all the traits mentioned above by **Teresa AM et al (2013)**, attributed to 96% accuracy of detecting the observed hip bone as female. The accuracy declines when losing the trait one by one and the sex determination shifts towards male.

v) In the study by **Gupta S et al (2014),** the most commonly observed shape of the obturator foramen was triangular in females and oval in males.

vi) Apoorva et al (2014) in dry hip bones and **Abiko et al** in 3D reconstructed CT of pelvis proved that increased angulation of the greater sciatic notch in the given population, incline the sex determination towards female side.

ACETABULAR PARAMETERS:

Salamon A et al (2004) with the precise aim of measuring the morphology and morphometry of the acetabulum and to establish the relation between the parameters took up a study on Croatian population. He examined 30 dry bones , the radius of curvature and depth of the acetabulum were analysed by computerized format. The radius of curvature was found by measuring the acetabular diameter and perpendicular

distance to the limbus and finally taking the one third of it. The depth was taken by taking three points close to the centre of the fossa by creating a virtual plane and taking the greatest distance. The mean value of radius of curvature and depth were 25.8 ± 1.9 mm and 30 ± 3.2 mm respectively. He also found the area of lunate surface as 2294 ± 329 mm^2 by using the formula 0.5 * 4 * r^2 * π.(r – radius of curvature.)

According to **Aksu T et al (2006)** , the anterior acetabular ridge's morphology was curved in 71(46.1%), straight in 36 (23.3%), angular in 26(16.8%) and irregular in 21 (13.6%). He took the acetabular diameter as the distance between the acetabular ridge which is near to the ischial body and anterior iliac margin getting intersected with acetabular ridge. The distance from the point deepest in the acetabular cavity to the horizontal scale kept on the acetabular surface is taken as the depth of the acetabulum. The mean acetabular depth and diameter of both the sexes were 29.49 ± 4.20 mm, 54.29 ± 3.8 mm respectively in Dokuz Eylul University on observing 154 hip bones of both the sexes in Turkey population. Significance at $p < 0.001$ and moderate positive correlation ($r = 0.498$) were observed between depth and diameter by pearson's correlation test.

In order to establish the gender difference in Nagano (Japan), **Maruyuma M et al (2010)** did a project by analyzing 50 male and 50 female hips. The anterior acetabular ridge, acetabular notch angle, anteversion angle, acetabulum inclination, antetorsion angle of the femur were the parameters taken. The commonest anterior acetabular ridge morphology was curved type (60.5%), the anteversion angle was 18.5 ± 5.8 in males and 21.3 ± 7.1 in females.

Gillard FC et al (june 2012) tested the hypothesis that the acetabulum is not a spherical one and to reflect that hip joint movement is more complex than the conventional ball and socket movement. He did a randomized 24 dry human pelvis study and analysed the mould by 3D laser scanner technique. He observed that anterior acetabular ridges were curved in most of the pelvis and the acetabular notch was wider and deeper in males than in females.

ParmaraG et al (2013) did measurements in 100 dry hip bones of Bhavnagar,Gujarat population (both the sexes). On observing the morphology of anterior acetabular ridge, it was curved in 61, irregular in 19 and straight in 20 hip bones. The range of depth of acetabulum was between 19.07 mm to 32.13mm in curved type, 23.33mm to 29.59 mm in irregular type, and 19.07mm to 30.31 mm in straight type. The average depth of the acetabulum in curved type is 26 mm, 26.25 mm in irregular type, 26.56 mm in straight type. The average diameter of acetabulum (mm) in curved, irregular, straight were 49.07 ± 3.6, 49.18 ± 4.05 and 49.79 ± 3.85 respectively. On the whole the average diameter was 49.23 ± 7.91 and the average depth (mm) was 26.16 ± 7.69. Highly positive correlation was exhibited between the parameters taken by adapting pearson's test ($P < 0.01$). The methodology was same as that Aksu T et al(2006).

Vyas K et al (2013) states that in his observed 152 dry hip bones of unknown sex and age belonging to Baroda population, curved anterior acetabular rim was found in 57(37.5%), straight shaped was found in 48(31.6%), irregular shaped in 28(18.4%) and angular shaped in 19(12.5%).The average maximum transverse diameter was measured as 4.79 cm on right side and 7.83cm on left side. Average depth of

acetabulum was 2.71 cm on right side and 2.65 cm on left side. He differs slightly from the methodology of by measuring the acetabular diameter as the maximum transverse diameter, which is convincing for us also.The depth was measured as of the previous study.

50 dry (25 left and 25 right) were analysed in Dyanand medical college,Ludhiana , Punjab. The mean diameter of acetabulum was observed as 5.13cm on right side and 5.03cm on left side. The mean depth of the acetabulum was 2.67 cm on right side and 2.64 cm on left side.the capacity of acetabulum was 36.68 ml on right side and 33.56 ml on left side. **Dhindsa GS et al (2013)** did this study by observing the Punjab population dry bones by using the same methodology of kintuvyas and also added the parameter of capacity by filling the plasticine in the acetabular cavity and dropping the mould in the water poured in the measuring jar, the amount of water displaced is the capacity of the acetabulum.(Archimedes principle).

Smitha M et al(2013) described her findings as curved acetabular ridge (anterior) is more common, the mean diameter of acetabulum was 51.87mm in males, 47.23 mm in females , the average depth was 27.46 mm in males ,26.15mm in females and the capacity was 30.48 ml in males,26.87 in females.

Devi TB et al (2014) did a study among Sikkim and Pondicherry population by including 100 dry bones from both the institutes (50 males, 50 females). They examined the diameter and depth of the acetabulum in both the population. They analysed the depth, diameter and anterior acetabular ridge morphology of the acetabulum to signify its importance during acetabular cup placing in hip arthroplasty

surgeries. They took the the distance between point on anterior ridge nearest to the body of the ischium and the point of anterior iliac margin intersecting the acetabular ridge (using digital vernier caliper).The measurement got was kept as the diameter of the acetabulum. The depth was found as per Aksu T et al methodology. The results obtained were statistically correlated by Pearson's test. The mean diameter obtained was 50.99 ± 1.99 mm and the mean depth was 28.32 ± 1.32 mm. He also examined the types of anterior acetabular ridge and on observation the types he got were curved (60), angular (27) , irregular (9) and straight (4). Positive and significant correlation was obtained between diameter and depth of the acetabulum.($p < 0.001$).

B)CADAVERIC HIP ACETABULUM ASSESSMENT :

In Maulana Azad medical college,**Chauhan R et al(2002)** studied 54 cadaveric hip joints with insitu soft tissues of North Indian hip joints (48 hip joints , 36 males, 12 females , 24 right and 24 left), by adopting the methodology that the measuring the greatest transverse diameter gives the acetabular diameter and the depth being the greatest vertical distance from the horizontal scale placed over the acetabular diameter and the deepest point in the acetabular cavity. The average depth (mm) of the acetabulum for males on right and left side was found as 27.49 ± 2.70 and 28.18 ± 2.58 respectively, for females on right and left side was found as 24.68 ± 1.20 and 25.70 ± 2.11 respectively. The diameter (mm) was found in males on right and left side was 47.10 ± 2.90 and 47.48 ± 3.05 respectively, for females on right and left side was 44.38 ± 3.01 and 46 ± 2.28 respectively. He also noted the vertical diameter of the head of the femur. Statistical analysis were analyzed between the measurements of right side of males and females , left side of males and females and also between the

right side and left side of males , between right side and left side of females. On the right side of males both the depth and diameter showed a significant change ($p< 0.05$) when compared to females, rest of the observed groups were statistically insignificant.

34 cadaveric pelvises were examined by **Eric V et al (2007)** by comparing the population of France, Germany, Austria and Germany and the report was made based on the iliopsoas impingement and its effect on acetabular cup implant. They came to a conclusion by keeping the psoas valley factor in mind that the exact acetabular morphometry is to be evaluated in the given population to achieve the successful acetabular cup implant in the hip arthroplasty technique which may be total or hemiarthroplasty.

According to **Varma L et al (2010),** the mean diameter of acetabulum was 45.31 mm in males and 40.43 mm in females ,the mean depth of the acetabulum was 28.26 mm in males and 26.91 mm in females . The same methodology as that of Chauhan et al was followed and the study was conducted on Bangalore population in 30 male and 20 female cadavers aged about 40 to 70 years. There was a significant difference between males and females but not with the side with respect to the parametes taken.

Patel J et al. (may,2013)in the study over Surat population states that in the observed 50 cadaveric hip joints (males 30, 15 right and 15 left, females 20, 10 right and 10 left) the mean depth(mm) of acetabulum was 29.96±2.96 (males, right side), 30.37 ±2.52 (males, left side), 27.44± 2.71 (females, right side), 27.57 ± 2.63 (females, left side) and the mean diameter(mm) of acetabulum was 45.42 ± 2.80 (males, right side), 45.07 ± 2.43 (males,left side) ,41.76 ± 2.28 (females ,right side),

41.98 ± 2.32 (females ,left side). The methodology was same as that of chauhan R et al. (2002) study. Left sided measurements were greater than that of right sided measurements on both the sides. No statistical significance was observed with the parameters, on analyzing all the subgroups.

Varma L et al (july 2013) explained in their study conducted in Bangalore medical college that , out of 60 human cadavers studied , the mean diameter of acetabulum was found to be 45.38 mm on right side and 45.54mm on left side in males, while in females it was 40.47 mm on right side and 40.18 on left side. The mean depth of the acetabulum was 28.09 on right side and 28.49 mm on left side in males, 27.12 mm on right side and 26.77 mm on left side in females. Males had greater measurements than females on all aspects. Statistically, gender difference was significant but not the sides. The methodology was similar to chauhan R et al. (2002).

Prasath A et al (2014) did a cadaveric morphometric analysis of acetabulum and femoral head in both the sexes of South Indian human cadavers. He dissected out 100 adult human cadavers (70 males, 30 females) and measured the diameter of the head of femur, acetabular diameter and the depth of the acetabulum. Gross outcome was that the measurements of the parameters in the males were greater than that of the females. The measurements of the acetabular diameter (mm) for males (right), males (left), females (right), females (left) are 45.14±2.87, 45.20± 2.85, 41.09± 1.95, 39.93 ± 2.97 respectively. The measurements of the acetabular depth(mm) for males(right) , males (left) , females (right), females (left) are 29.79 ± 2.92 , 30.09 ± 2.56 , 28.74 ± 2.42 , 27.97 ± 2.03 respectively. On analyzing by SPSS, it is assessed that there is a significant difference between males and females (males > females) in both diameter

and depth attributing to shallow acetabulum in females, owing to high chance of osteoarthritis.

C) RADIOLOGICAL ASSESSMENT OF ACETABULUM:

Broughton et al (1989) suggested that CE angle was the indispensable tool for assessing hip dysplasia in child's hip. He observed 474 hip joints in Melbourne population and the CE angle rangle was between 0 to 42.

Yoshimura N et al.(july,1998) conducted studies in japan and Britain (1303 men , 195 women) prospectively by obtaining plain normal Xrays of pelvis AP views, to attribute to the prevalence of osteoarthritis by seeing the acetabular dysplasia in these two different ethnic groups by measuring the CE angle and acetabular depth. The mean CE angle among men in britain was 36° and in japan was 31°, among females in britain was 37° and 31° in japan , the mean values of acetabular depth lower(9.2 mm males,8.9 mm females) in japan than britain (14.4 mm males,14.1 females) . The mean acetabular depth was statistically lower in Japan on par with Britain. ($p < 0.001$). CE angle was not statistically significant on comparing both the goups.The final conclusion of significant relation between acetabular dysplasia and osteoarthritis could not be arrived on etiological ground.

Han CD et al.(august,1998) prospectively documented his measurements in the observed 591 normal adult hips (normal X rays of pelvis AP views) of Korean population. The measurements were:

1) CE angle: The angle formed between a line joining both the femoral heads and the perpendicular line joining the centre of the respective femoral heads.

2) AA: It is defined as the angle formed between the line joining the inferior tip of two pelvic tear drops and the line joining the lateral edge of acetabular roof on the corresponding side.

3) AD: It is the longest vertical distance between the line joining the lateral margin of the acetabulum and upper end of the pubic symphysis to the roof of the acetabulum.

4) ARO:It is defined as the angle between the line connecting the lateral edge of the acetabularroof touching the lower iliac tip of acetabular surface and a line parallel to the pelvic tear drop.

5) RA**:**It is determined by the angle inbetween the line along the lateral side of the ilium on the acetabular surface and a line parallel to the pelvic tear drop**.**

The mean CE angle was 32.6 ± 5.7° for males, 32.3 ± 6.8° for females,the AA was 36.5 ± 3.5° in males,37.5 ± 3.8° in females. The average acetabular depth was 10.9 ± 2.7 mm (11.5 ± 2.6 mm in males, 10.2 ± 2.6mm in females). The ARO , average value was 6.6 ± 5.6 ° (males 5.2 ± 4.8°, females 8 ± 5.9°) , the average RA was 17.4 ± 9° (18.6 ± 8.4° in males ,16.1 ± 9.4° in females). In the study there is no significant difference in the ce angle and acetabular angle towards age where as other parameters had. Likewise ce angle had no significance towards gender where as others had. If CE angle is less than 20° or AA more than 45° (44 in males, 45 in females) acetabular dysplasia is diagnosed.

Nelitz M et al (1999) on assessing the reliability of the radiological measurements for diagnosing hip dysplasia he examined 100 hip radiograps (AP) of both sexes with the age ranging from 19 to 32 years. He looked at the CE angle, AA,

acetabular index of weight bearing zone , acetabular head index , lateral subluxation and neck shaft angle which were ,23.5±7.8°, 43.5±4.3°,10.8±7.6,25.7 ± 7.9, 8.4 ± 2.6 mm and 137.3 ± 9° respectively. He concludes with his review that for children over 8 years AA is helpful for diagnostic and over 6 year CE angle, neck shaft angle plays a significant role for dysplasia . In adults he concludes with his study that CE angle of wiberg, AA , LS, acetabular head index, Acetabular index of weightbearing zone all are useful for planning the treatment in dysplastic hips.

Noble PC et al (2000) did a research on 21 dysplastic hips and 15 normal hips using 3D reconstructed 3mm slices of CT Pelvis images in Texas population and found the average values for AV, AD, CE angle, AASA as 16.4 ± 7.6°, 20.1 ± 3.1mm, 29.4 ± 8.6°, 78.9 ± 6.4° respectively . He stresses that lateral subluxation inturn leading to change in the acetabularanteversion may lead to acetabular dysplasia.

Tan L et al.(2001) in Trakya university,conducted a study in 30 pelvis radiographs of AP view belonging to the 15 patients (age group of range 3 to 36 months) , out of which they concluded on analyzing parameters like AIA,CE angle, DTW, tear drop figure, AA that no single parameter is useful for evaluation of acetabular dysplasia, a combination of parameters must be used for evaluation.

Malawian population was studied by **Msamati BC et al(2003)** for assessing the AA and CE angle and to observe its influence over dysplasia. The AA in men were (35.52° right, 34.21° left), in females were (29.43° left, 29.29° left). The range of CE angle in men were 19° to 51° and in female were from 15° to 52°. They reported

that these parameters had more significance towards diagnosing hip dysplasia in Malawian population when comparing with Chinese and Nigerian population.

On a cross sectional study conducted by **Jacobsen et al (2005)** on 2232 women and 1336 men (Copenhagen population) , falling under the mean age group of 20 – 91 years , various risk for hip osteoarthritis like age , chronic hip pain , occupational load stress , BMI , smoking and hip dysplasia were analysed for etiological correlation. Age and hip dysplasia had a strong correlation as an etiological factor for osteoarthritis. With an increase of both the parameters the risk for osteoarthritis also increased.

CE angle of Wiberg is also used for assessing the pelvic asymmetry describes Boulay **C et al (2006)**. It is one of the homologous variables for determining the symmetrical orientation of the hip bone in 3D.

Umer M et al (2006) in Aga khan university, Karachi, Pakistan on seeing 522 patients X rays pelvis AP explained 7 morphological measurements as

1) CE angle, 2) AA were similar to Arsic et al study,

Others are:

3**) Acetabular Roof Obliquity:**It is defined as the angle between the line connecting the lateral edge of the acetabular roof touching the lower iliac tip of acetabular surface and a line parallel to the pelvic tear drop.

4) Depth To Width Ratio: Width is determined by the line joining the lateral edge of acetabulum to the pelvic tear drop. Depth is assessed by the previously mentioned method. Then the depth to width ratio is taken.

5) Extrusion Index:is a ratio between the two measurements.

The horizontal distance between the vertical lines drawn through the medial and the lateral edge of the femoral head (b) and the distance between the lateral edge and the outer edge of the acetabulum. (a) . Extrusion index is (a/a+b).

6) Lateral Subluxation: The distance between the tear drop and the medial most edge of the femoral head.

7) Peak To Edge Distance: It is the horizontal distance between the lateral edge of the acetabulum and the highest point of the sourcil.

The mean CE angle was 31.25°± 7.98° , AA was 39.46°± 6.04° , DTW 0.32 ± 0.06 , ARO 7.86° ± 6.55° ,extrusion index 0.18 ± 0.08 ,lateral subluxation 9.9 ± 2.71mm and peak to edge distance 15.65± 3.04 mm. Statistical package for social sciences (SPSS) was used to analyze the measurements and they concluded that CE angle as most significant diagnostic indicator of acetabular dysplasia (7.3 %) of singaporean population.($p < 0.01$). CE angle correlated stongly with AA , roof obliquity, EI, PED. Significant difference was seen in sexes between the CE angle and EI. Age acted as a confounding variable on accounting to EI and AA.($P< 0.05$).

Daysal et al (2007) established a relation between joint space width , CE angle and AD in the study conducted among Turkey population. He observed 180 normal

hip joints of both the sexes and found that CE angle has strong correlation with AD than JSW.

Moussa M et al (march 2007) in the Saudi population, after examining 104(55 males, 49 females) normal pelvic radiographs of the patient (aged over 40) who came for intravenous pyelogram, reported that the mean CE angle of the population was 33.3 ± 4° (males 34 ± 4°, females 32.6 ± 4°) and the mean AA for the males was 34.3 ± 4.6° and for females was 36.6 ± 4.2° . On analyzing statistically there was a gender significance (women more prone for hip dysplasia) when keeping CE angle as a scale. ($p<0.05$). There was a negative correlation between CE angle and AA. ($r = -0.019$). No significant difference between right and left hips. Age had no relation to CE angle and AA.

The mean AA, CE angle, AV, AD were 39.2°, 32.7°, 18.2°, 2.5 cm respectively as measured by **Saikia KC et al(2008)** . He observed 104 normal hip joint in the north eastern population of India.

Joint space width (superolateral, superomedial) was examined by **Im GI et al(2009)** in Korean population. 428 patients who had normal pelvic X rays were recruited and the joint space width was evaluated; superolaterally the mean with SD was 4.88± 0.99 mm and superomedially the value was 4.69 ± 1.04 mm. CE angle had inverse correlation with both the JSW. The age, BMI and male gender had negative correlation with supeomedial JSW but had positive correlation with superolateral JSW.AD was positively correlated with the superomedial JSW but not with the superolateral JSW.

Johnsen K et al (june, 2009) started their study to see the influence of acetabular dysplasia over osteoarthritis in 315 middle aged sami population in norway. The result given by them was there is no significant relation between acetabular dysplasia over osteoarthritis and that too radiological parameters does not signify as the indicators of the clinical condition.

Seven acetabular parameters were observed by **Oladipo GS et al (2010)** to check for the prevalence of acetabular dysplasia. 150 hip joints in plain X ray AP view were observed in the Nigerian population and the results for right side mean values in males were CE angle, AA, DTW, ARO, EI, LS, PED were 32.43±7.74°, 35.47± 4.11°, 0.38 ± 0.04, 15.80 ± 8.72°, 0.48 ± 0.003, 4.12 ± 1.27 mm, 6.35 ± 1.58mm respectively, for left side mean values in males were CE angle, AA, DTW, ARO, EI, LS, PED were 34.80 ± 6.99°, 35.60 ± 4.70° , 0.39 ± 0.05 , 16.97 ± 7.69°, 0.47 ± 0.005, 4.02 ± 1.27mm , 6.35 ± 1.58mm respectively , for right side mean values in females were CE angle, AA, DTW, ARO, EI, LS, PED were 33.17 ± 6.80°, 36.65 ± 4.61°, 0.44 ± 0.06, 12.34 ± 3.69°, 0.48 ± 0.047, 3.96 ± 0.68 mm, 6.14 ± 0.36 mm respectively, for left side mean values in males were CE angle, AA, DTW, ARO, EI, LS, PED were 33.98 ± 6.09°, 35.66 ± 4.68°, 0.46 ± 0.06, 12.74 ± 4.17°, 0.46 ± 0.057, 3.99 ± 0.67 mm, 6.14 ± 0.35 mm respectively. He statistically proves that CE angle is the powerful indicator of acetabular dysplasia and it also has a strong correlation with AA, LS, and PED.

Dudda M et al.(october ,2011) in studying the morphological difference between the chinese and caucasian female hips for revealing the osteoarthritis nature in different ethnic groups, he is concluding that caucasian women have CE angle

suggestive of impingement (CE angle > 35 degrees),the chinese women have CE angle suggestive of dysplasia(CE angle < 20 degrees). Of all the comparisions the statement is caucasians may be at higher risk for osteoarthritis than chinese because of the impingement. He studied 400 female Xrays pelvis of AP view, 200 in each group.

Baharuddin MY et al.(december 2011) stated after examining 120 CT pelvis, that in 60 malay subjects the CT acetabular findings of mean CE angle, AA, AIA, AV, AD, JSW, AASA, PASA were 31.69 ± 5.48°, 42.35± 3.24°, 4.27 ± 4.03°, 14.99 ± 5.05°, 15.49 ± 1.70 mm, 5.48 ± 0.80, 61.19 ± 6.72°, 92.80 ± 6.27° respectively. The right and left sided differences were documented in males **(Table 2a)** and females **(Table 2b)**.The methodology to derive these parameters were same as of Arsic et al and Umer et al . There was a significant gender difference but not with with the sides. CE angle had weak positive correlation with rest of the angles.

Jeremic D et al. (2011) describes after analyzing 370 X rays AP VIEW in the Serbian population, that the average AA was 38.3 ± 3.6°(in males 37.5 ± 3.6 degrees,38.5 ± 3.9 in females), CE angle average was 33.5° ± 6.5° (in males 33.6° ± 5.8°, 33.3° ± 6.9° in females), AD mean was 11.9 ± 2.8 mm, (12.5 ± 2.7 mm in males, 11.2 ± 2.7 mm in females),the ARO mean was 7.6° ± 5.7° (6.2° ± 4.9° in males,9° ± 6° in females).CE angle and AA has no significant difference in age. CE angle has no significant difference related to gender .If CE angle less than 25° , AD less than 9 mm , AA more than 45° (44° in males, 45° in females) ,ARO more than 10° then acetabular dysplasia is suspected.The proportion of acetabular dysplasia was 2.9%. By using SPSS software, Paired t test and Pearson's correlation test, all the

Males:

S.NO	PARAMETERS	RIGHT	LEFT
1.	CE angle	32.71±5.26	32.64±5.72
2.	AIA	9.42±3.69	10.64±4.76
3.	AA	42.05±3.4	41.52±3.08
4.	AV	42.96±3.37	42.87±3.05
5.	AD	16.05±1.75	16.29±1.24
6.	JSW	5.99±0.76	5.93±0.95
7.	AASA	63.02±6.11	61.58±9.55
8.	PASA	92.75±6.58	92.73±6.01

Table 2a: Male Acetabular parameters in CT by Baharuddin MY et al

Females:

S.NO	PARAMETERS	RIGHT	LEFT
1.	CE angle	29.32±5.60	32.10±4.84
2.	AIA	9.56±3.58	10.19±4.10
3.	AA	42.96±3.37	42.87±3.05
4.	AV	42.96±3.37	42.87±3.05
5.	AD	15.29±5.04	15.06±4.35
6.	JSW	5.81±0.72	5.64±0.76
7.	AASA	59.40±7.72	60.75±5.62
8.	PASA	92.26±6.54	93.46±6.19

Table 2b : Female Acetabular parameters in CT by Baharuddin MY et al

measurements were assessed, in which the CE angle had positive correlation with AD but not with AA and ARO.

Park JM and Im GI (2011) in a study conducted over four hundred and twenty eight consecutive korean patients with no evidence of hip osteoarthritis ,AP radiographs of pelvis were taken and the mean CE angle was 37.9 °± 5.6 ° ,the mean AD was 11.6 ± 2.7 mm and the mean AA was 38.1°± 4.2 °. There was a significant direct relation between age with CE angle and inversely proportional relation between age with AA and AD. There was positive correlation of CE angle with AD and inverse correlation with AA. No significant gender difference was observed.Hip dysplasia is when CE angle < 25 °, AD < 9 mm and AA > 42°.

320 adult (640 asymptomatic hips) X rays of pelvis (AP view) were examined by **JeremicD, ZivanovicI, vulovic M (2011)** in the Serbian population , the results given by them were ,the CE angle mean was 33.5 °± 6.5 °, AA angle mean was 38° ± 3.8°, AD mean was 11.9 ± 2.8 , ARO mean was 7.6° ± 5.7° degrees and RA mean was 18.4° ± 10° degrees. In males the mean CE angle, AA, AD, ARO, RA were 33.6° ± 5.8°, 37.5° ± 3.6°, 12.5 ± 2.7mm, 6.2° ± 4.9°, 19.6° ± 8.5 respectively. In females the mean CE angle, AA, AD, ARO, RA were 31.3° ± 6.9°, 38.5° ± 3.9°, 11.2 ± 2.7 mm, 9° ± 6° , 17.1° ± 9.5° respectively.There was significant differences in CE angle, AA, AD, ARO and RA related to gender.($p < 0.01$), analyzed by paired t test in SPSS software. Females are more prone for dysplasia than males.

Templated centre of contained femoral head with picture archiving and communicating system is superior to traditional method of finding the centre of the

femoral head says **Anderson et al (feb 2011)** in the study conducted over 30 X ray pelvis.

Vidhyadhar V et al (2011) did a study on 50 dysplastic radiographs of pediatric population in California and revealed that CE angle, Neck shaft angle of femur and Acetabular index, neither of these parameters were conclusively satisfying for diagnosing DDH. So he is suggesting for a combined parametric approach

A case control study on Hip morphology parameters risk on end stage osteo arthritis of the hip was done by **Alex SN et al (2011) (Chingford study)** on 1003 women in which the cases were patients underwent Total hip arthroplasty and the controls were the patient with normal hips. Cam deformity was common among cases than controls , cases had CE angle of about 29.5° where as the controls had 34.3°, the cases had the extrusion index of 0.25 where as the controls had the extrusion index of 0.185.

Arsic S et al (june 2013) conducted a study in their serbian population (aged over 20 years), in which 58 CT of acetabulum with 0.5 mm thickness were analysed . The measurements were defined as

1)CE Angle: It is described as the angle between the line joining the centre of femoral head and lateral margin on the acetabular roof and the vertical line from the centre of femoral head.

2)Acetabular Depth: It is the maximum distance from acetabular roof to the line joining the two lateral margins of the acetabulum.(upper margin – roof , lower margin – tear drop).

3)Acetabular Angle: The angle is formed by the angle between the line connecting the left and right sides of the pelvic tear drop and a line joining the lateral edge of the acetabular roof and the inferior tip of the pelvic tear drop.

4)**Acetabular Index Angle:** The horizontal line passing through the fovea of the head of the femur and a line connecting the lateral part of the acetabularlimbus and the fovea on the femoral head.

5)Acetabular Version: The anterior and the posterior margins of the acetabulum should be 1.5 cm apart as measured from the centre of the femoral head in a plane that is vertical to the anterior aspect of the acetabular rim.

6)Joint Space Width: 3 measurements are taken through the joint space.

1)Through fovea of the femoral head.

2)Laterallimbus of the acetabulum.

3)Lower part of acetabulum.(near the inferior tip of the tear drop.)

7)Anterior Acetabular Sector Angle: The angle between the centre line of both femoral heads and the line from centre towards the anterior margin of acetabulum.

8)Posterior Acetabular Sector Angle: The angle between the centre line of both femoral heads and the line from centre towards the posterior margin of acetabulum.

In the results , the mean CE angle, AIA, AA, AD, JSW, AV, AASA, PASA were 47.19° ± 7.17°, 25.50° ± 5.3°,37.2° ± 5.14° , 24.16 ± 6.7mm, 4.99 ± 1.47mm , 23.62° ± 5.55°, 65.05° ± 12.15°, 114.52° ± 9.65° respectively.In males the mean CE

angle, AIA, AA, AD, JSW, AV, AASA, PASA were 48.42°± 7.91°, 25.15° ± 5.18°, 36.14° ± 6.56°, 26.47 ± 7.73 mm , 4.78 ± 1.38mm, 21.86° ± 5.54°, 68.72° ± 14.2°, 111.67 °± 6.57° respectively. In females mean CE angle, AIA, AA, AD, JSW, AV, AASA ,PASA were 45.99° ± 6.27°, 25.83° ± 5.49°, 38.2° ± 3.11°, 22.01 ± 4.78 mm, 4.96 ± 1.05mm, 25.26 ± 5.13°, 63.7 ± 10.55°, 115.25 ± 7.28° respectively. On comparing the mean values, there was no right and left sided differences significantly but between gender there was a significant difference in AD , AV.

Monazzam et al (aug 2013) revealed that the radiological measurements taken in the radiographs, CT or radiographic imposition over cadaveric study should be standardized with the accountability of tilt and rotation to avoid the assessment of acetabular over coverage.

2011 (841 males, 1170 females) 19 year old Norwegian adults were made to participate in the cohort study conducted by **Laborie LB et al (2013).** CE angle and AA were taken as parameters for assessment in plain Xray pelvis. The CE angle for males was 32.1 ± 6.1 and for females was 31 ± 6.1 and the AA for males was 38.8 ± 3.5 and for females was 40.7 ± 3.5.

D)FETUS STUDY: (CADAVERIC ASSESSMENT)

Ralis Z et al (1973) dissected out 44 human hip joints (15 aborted fetuses, 29 dead children of various age groups ranging from eleven and a half weeks embryo to eleven year old child. Fetuses were measured using Crown rump length and correlated with the gestational age. The background of the study was to analyse the theory that, the deeply set cavity of the acetabulum from its time of formation,

gradually becomes shallow, at birth it attains the maximum shallowness and then the depth of the cavity increases after birth till adolescence. Simultaneously the depth increases, but the shape of the acetabulum became less hemispherical due to the factor that the depth to diameter percentage decreased. This was based on analysis by Sainton (1892) and Le damany (1912).

The methodology was proceeded in such a way that , first all the muscles plus the capsule around the hip joint was removed , secondly the labrum was kept intact ,thirdly the ligament of head of the femur was cut and lastly the acetabular cavity was visualized in toto. A digital vernier caliper, two marker wires were taken. The greatest transverse width of the acetabulum is taken as the diameter of the acetabulum.(a1). The depth of the acetabulum is measured with the help of the two wires. The first wire is placed horizontally across the diameter of the acetabulum over the labrum and the second wire was kept at ninety degress to it. Then the distance between the deepest point of the cavity to the acetabular rim was taken as the depth of the acetabulum.(a2). Then the change in acetabular shape in due course of the gestational age was assessed by the formula a2 / a1 * 100. (i.e depth / diameter * 100).

The results were , the acetabulum became maximum shallow at birth , then the depth of the cavity increased after birth to enclose the femoral head, the shape of the acetabulum became less hemispherical (a2 / a1 * 100 < 50 %) . This whole thing was "**STABILITY IS SACRIFICED FOR MOBILITY**" during birth but it carries the high risk for congenital dislocation of hip. He also observed that, globular head of the femur becomes hemispherical during birth, inturn contributing to the congenital dislocation of the hip.

Morphometric assessment of development of the human fetal hip joint was done by **Walker JM et al (1981)** in 140 human fetuses (canada population) which were obtained from abortions during the perinatal period. The crown rump length of the fetuses was from 8.7 cm to 40 cm and the gestational weeks of the fetuses attributed to the study were between 12 and 42 weeks of age. The joint cavity was dissected out and in acetabular part diameter, depth, shape were measured and in the femoral part the diameter of the head of the femur, width and length belonging to the femoral head, neck shaft angle and femoral torsion were measured. All the measurements were taken with the help of the dissection microscope. The acetabular diameter was the greatest transverse diameter which was observed with the help of stereoscope and stage micrometer. The acetabular depth was measured with the help of the pointer after leveling the socket on the calibrated vernier mounted over the mechanical stage of the stereoscope. The acetabular measurements were depicted in the form of graph which showed that, both the acetabular diameter and depth increases with gestational age but the acetabular shape becomes less hemispherical with the increase of gestational age. The main concept of the study was to analyse the significance of each parameter and their clinical correlation with congenital dislocation of hip.

The statistical analysis done through SPSS software revealed there is no significant difference in any of the values between males and females, also between right hip and left hip. Acetabular depth is regarded as the slowest growing one, the acetabular diameter had strong correlation with head of the femur diameter which proves their embryological significance in same mode of origin.

Uysal LL et al (2004) dissected 15 male and 15 female fetuses (Turkey population) which were aborted. 60 hip joints were observed after removing the muscles and the capsule attached, labrum was kept intact. The vertical, transverse diameter of the femur, the acetabular diameter, the acetabular depth and the femoral head's length, width were assessed. The acetabular diameter is the greatest transverse diameter while the acetabular depth is made out from the cast made from the cavity.(distance from top of the cast to the bottom of the cast). The results of the acetabular measurements were made **(Table 3a, 3b)** and statistically analysed .

Acetabular diameter and the transverse head diameter of the femur strongly correlated statistically and also the vertical diameter and the acetabular depth strongly correlated statistically. Gestational age had stong positive correlation with the observed parameters and was significant too.($p < 0.05$).

S.No	Parameters	Second Trimester		Third Trimester		2 nd Trimester: Total Mean N=18	3 rd Trimester: Total Mean N=12	Second And Third Trimester Total Mean N= 30	Total Mean (Males) N= 15	Total Mean (Females) N= 15	Total Mean: N= 30
		Males N=9	Females N= 9	Males N=6	Females N=6						
1.	Acetabular depth(mm)	5.14 ± 0.72	5.51 ± 1.12	6.87± 0.65	7.92 ± 2.60	5.33 ± 0.93	7.39 ± 1.89	6.15 ± 1.71	5.83 ± 1.10	6.47 ± 2.15	6.15 ± 0.31
2.	Acetabular diameter(mm)	8.67 ± 1.35	9.20 ± 1.20	12.69 ± 1.34	13.43 ± 0.69	8.94 ± 1.27	13.06 ± 1.09	10.58 ± 2.37	10.28 ± 2.42	10.89 ± 2.36	10.58 ± 2.36

Table 3a : Acetabular parameters in right side of fetus in second and third trimester by Uysal LL et al.

S.No	Parameters	Second Trimester :		Third Trimester		2 nd Trimester: Total Mean N=18	3 rd Trimester: Total Mean N=12	Second And Third Trimester Total Mean N= 30	Total Mean (Males) N= 15	Total Mean (Females) N= 15	Total Mean: N= 30
		Males N=9	Females N= 9	Males N=6	Females N=6						
1.	Acetabular depth(mm)	5.17 ± 0.41	5.42 ± 0.78	7.10 ± 0.62	8.02 ± 2.46	5.29 ± 0.62	7.56 ± 1.78	6.20 ± 1.64	5.94 ± 1.09	6.46 ± 2.06	6.20 ± 1.64
2.	Acetabular diameter(mm)	8.69 ± 1.23	8.86 ± 1.21	12.67 ± 1.21	13.24 ± 1.36	8.77 ± 1.19	12.96 ± 1.26	10.44 ± 2.40	10.28 ± 2.34	10.44 ± 2.40	10.44 ± 2.40

Table 3b : Acetabular parameters in left side of fetus in second and third trimester by Uysal LL et al.

MATERIALS AND METHODOLOGY

ETHICAL CLEARANCE: After obtaining the due approval from the IHEC (Institutional Human Ethics Committee) of our institution for the dissertation, the plot for the study was framed in retrospective style for human acetabulum with the assessment of

A) Dry hip bones. (Adult)

B) Cadaveric hip bones. (Adult)

C) X rays. (Pelvis AP view) (Adult)

D) CT scans. (Abdomen and pelvis) (Adult)

E) Fetuses. (Cadaveric dissection).

Waiver of consent was obtained for all the study groups.

SAMPLE SIZE:

Sample size was decided as 500, based on time and resource constraint, with the distribution of:

S.NO	MATERIAL	NUMBER	SAMPLE SIZE (ACETABULUM)
1.	DRY HIP BONES.	100	100
2.	CADAVERIC HIP BONES.	30	30
3.	X RAYS PELVIS AP VIEW.	105	210
4.	CT SCAN ABDOMEN AND PELVIS	50	100
5.	FETUSES	30	60
	TOTAL		**500**

SAMPLE INCLUSION AND EXCLUSION CRITERIA:

INCLUSION CRITERIA:

Dry hip bones, cadaveric assessment: (males and females)

- Normal hip bones.
- Hip bones and cadaveric hip bones were obtained from adult specimens, as per department records.
- Hemispherical acetabulum with cartilage lining it should be smooth and horse shoe shaped without any tear.(cadaveric acetabula)

Radiolographical assessment: (males and females)

- Normal pelvis X– rays AP.
- X rays pelvis> 18 years of age.
- Normal abdomen and pelvis CT scans.
- CT abdomen and pelvis > 18 years of age.

Fetus study (cadaveric assessment):

- Aborted Foetuses of gestational age from 12 to 40 weeks.
- Foetuses without any limb body wall defects.
- Foetuses without any structural acetabular defect.
- Foetuses without acetabular labrum pathology.

EXCLUSION CRITERIA

Dry hip bones, Cadaveric assessment: (males and females):

- Fractured hip bones.
- Other pathological hip bones.
- Cadaveric hip bones with soft tissue damage.

Radiological assessment: (males and females):

- Pelvic X rays AP view diagnosed with fracture.
- Pelvic X rays AP view with carcinoma and any other pathology reported.
- X – Rays<18 years of age.
- Computed tomograms (CT) abdomen and pelvis: axial and coronal views with fracture, carcinoma and any other pathology reported.

Fetus study (cadaveric assessment):

- Aborted fetuses with limb body wall defect.
- Fetuses with acetabular cartilage and labrum tear.

A) DRY ACETABULUM:

MATERIALS: (Fig 2a , Fig 2b)

1) 100 (53 males, 47 females) Human Hip bones.
2) Vernier calliper.(digital)
3) Metallic scale.
4) Plasticine.
5) Measuring jar.
6) Water.

Acetabula of 100 dry hip bones were grouped and Sex determination was done by using the following table:

S.NO	PARAMETERS	MALES	FEMALES
1.	Iliac crest	More rugged,more medially inclined in anterior end,	smooth,less curved
2.	Greater sciatic notch	Buikstra,Ubelaker grading GRADE 1 (Acute angle)	Buikstra,Ubelaker grading GRADE2to5.(Obtuse angle)
3.	Ischial spine	More inverted	Not inverted
4.	Ischio pubic ramus	Rough,everted	Smooth,Noteverted
5.	Pubis – ventral arc	Absent	Elevated ridge present
6.	Shape of ischiopubic ramus.(medial aspect)	Broader with absent of ridge.	Vertical with a prominent ridge.
7.	Ischiopubic concavity	Absent	Present.
8.	Obturator foramen	Oval	Triangular
9.	Preauricular sulcus with pits.	Less prominent or absent	More prominent
10.	Muscular markings	More prominent	Less prominent

Table 4: sex determination of hip bone. (Fig 1a to 1f)

Based on the analysis made 53 male hip bones and 47 female hip bones were classified. Right and left sides of the acetabulum were analyzed with the corresponding sexes.

SEX DETERMINATION OF HIP BONE

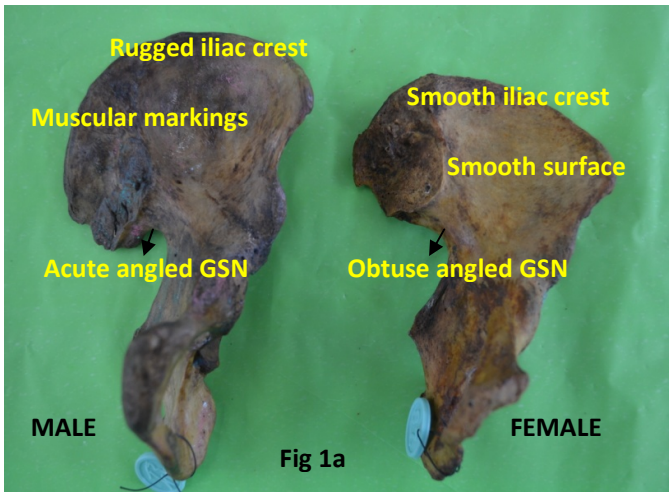


Fig 1a

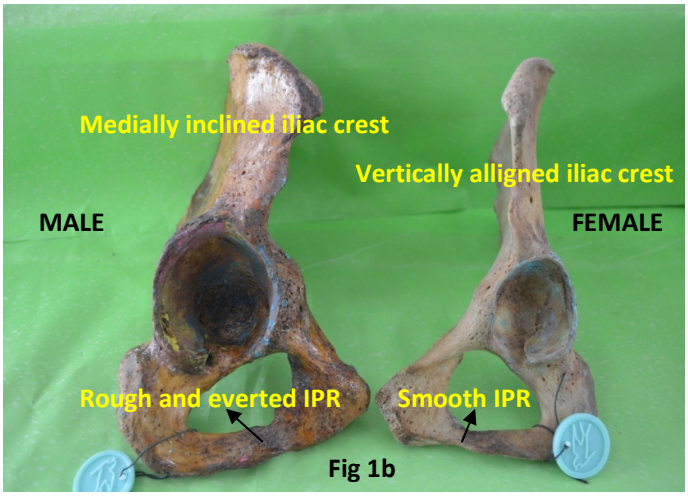


Fig 1b

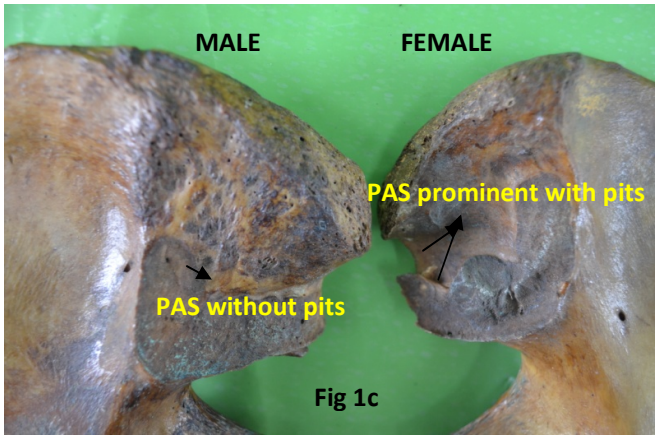
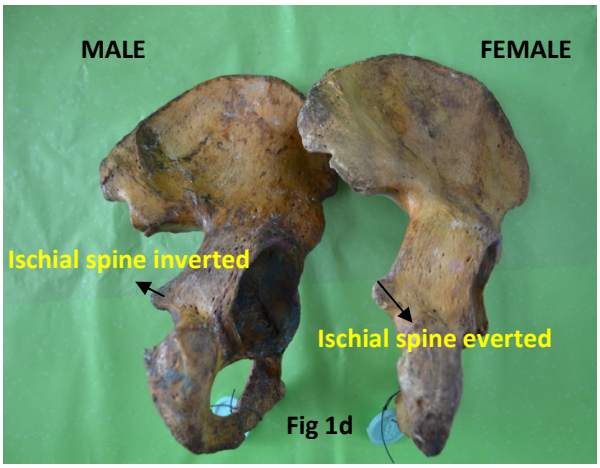
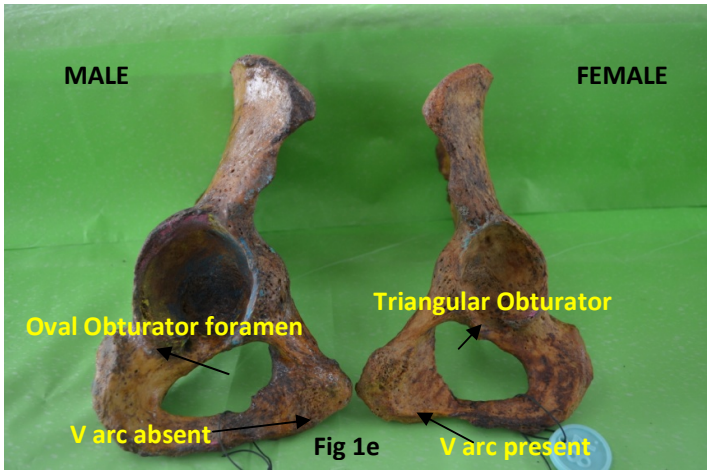
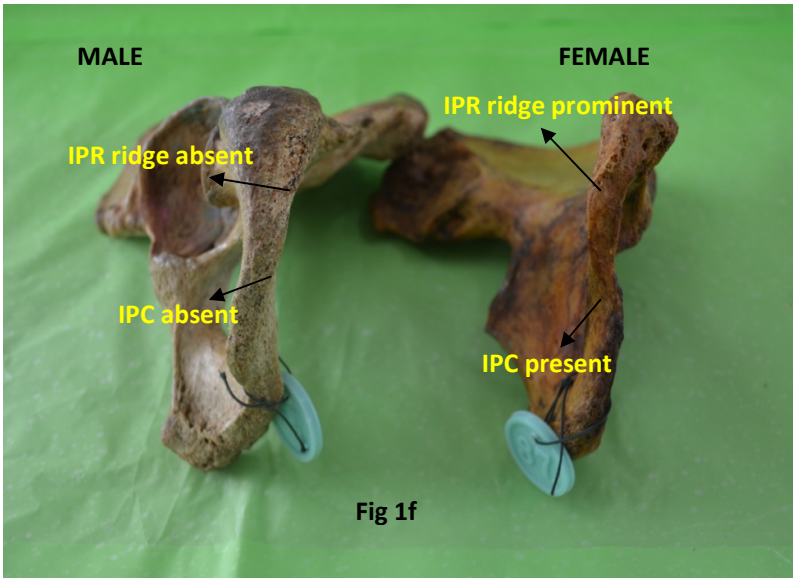


Fig 1c


MALE
FEMALE
Ischial spine inverted
Ischial spine everted
Fig 1d


MALE
FEMALE
Triangular Obturator
Oval Obturator foramen
V arc absent
Fig 1e
V arc present


MALE
FEMALE
IPR ridge prominent
IPR ridge absent
IPC absent
IPC present
Fig 1f

METHODOLOGY:

In 100 (53 males, 47 females) dry hip bones, following acetabular parameters were measured:

1. Diameter of the acetabulum.
2. Depth of the acetabulum.
3. Capacity of the acetabulum.
4. Shape of the anterior acetabular ridge.

1) **Diameter of the acetabulum:**

With the help of the digital vernier caliper the maximum transverse diameter of the acetabulum was measured. Maximum transverse diameter of the acetabulum is taken as the diameter of the acetabulum. **(Fig 2c)**

2**) Depth of the acetabulum.**

Maximum vertical distance from the brim of the acetabulum to the deepest point in the acetabular cavity is measured with the digital vernier caliper by placing the metallic scale horizontally over the brim of the acetabulum. The distance measured is calculated as the depth of the acetabulum. **(Fig 2d , Fig 2e)**

3) **Acetabular capacity:**

Plasticine is fixed to the size of the acetabulum cavity such that it fills the till the brim and then the plasticine is transferred to the graduated measuring cylinder filled with

DRY ACETABULAR PARAMETERS

Fig 2a

Fig 2b

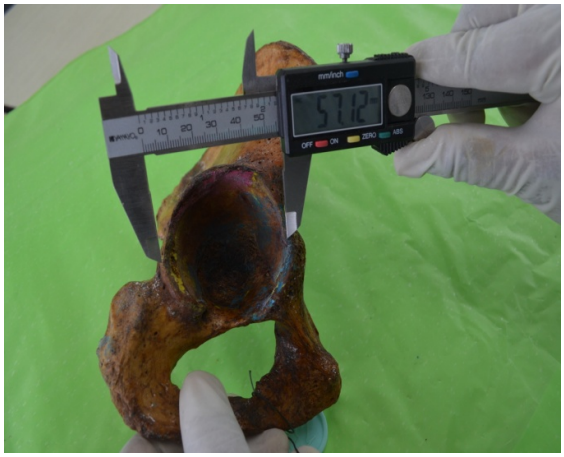


Fig 2c : Diameter

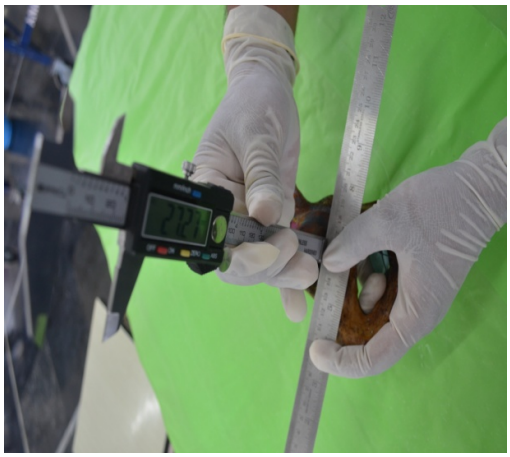


Fig 2d: Depth

Fig 2e : Depth

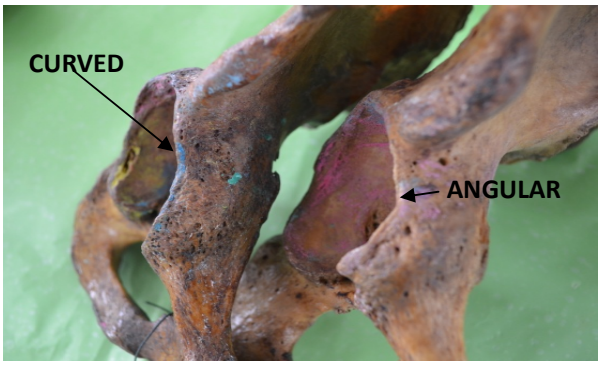


Fig 2f (Anterior acetabular ridge)

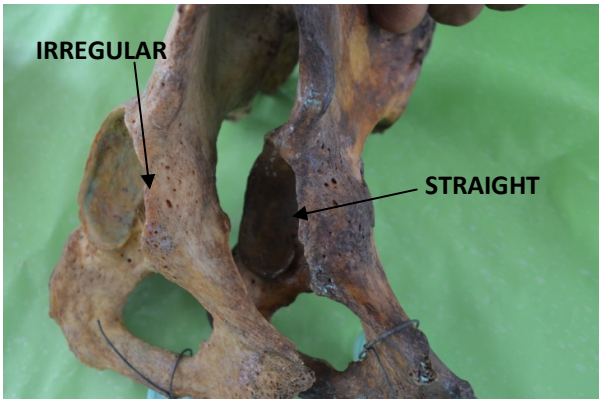


Fig 2g (Anterior acetabular ridge)

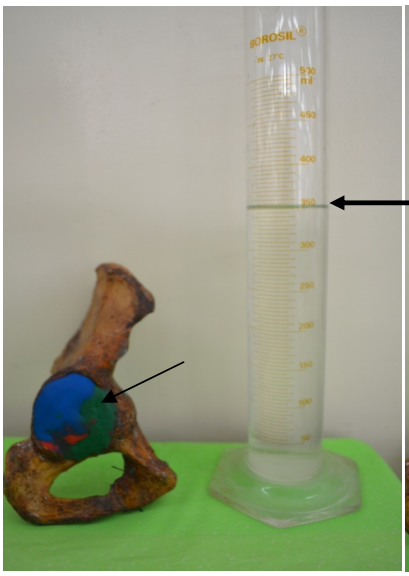


Fig 2h(Capacity)

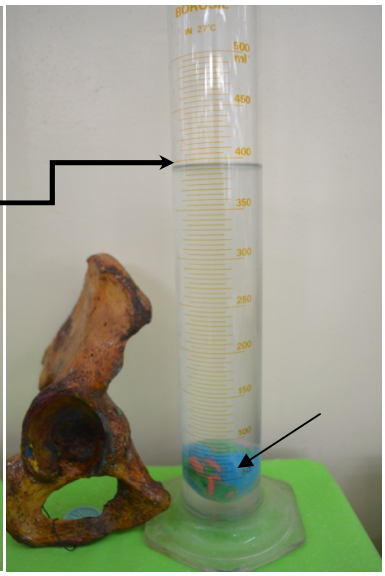


Fig 2i(Capacity)

water. The amount of water displaced gives the capacity of the acetabulum**.(Fig 2h, Fig 2i).**

4) **Anterior acetabular ridge:**

Type of the anterior acetabularridge is observed as irregular,curved,straight and angular is documented. **(Fig 2f, Fig 2g)**

B) CADAVERIC ACETABULA:

MATERIALS: (Fig 3a, 3b)

1) 30 (15 males, 15 females) Cadaveric hip bones.
2) Digital vernier caliper.
3) Metallic scale.
4) Plasticine.
5) Measuring jar.
6) Water.

METHODOLOGY:

In 30 [(15males, 15 females) (7 male and 7 female cadavers were attained in toto , one right, one right cadaveric hip were attained from male and female cadavers respectively)] , the acetabular parameters measured with soft tissues in situ were:

1. Diameter of the acetabulum.

2. Depth of the acetabulum.

3. Capacity of the acetabulum.

CADAVERIC ACETABULAR PARAMETERS

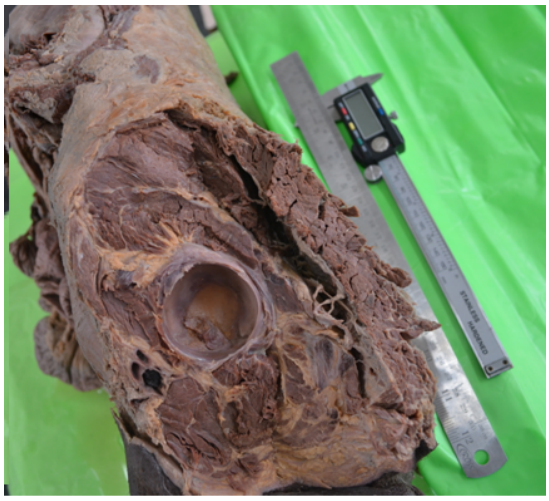


Fig 3a

Fig 3b

Fig 3c : Diameter

Fig 3d:Depth

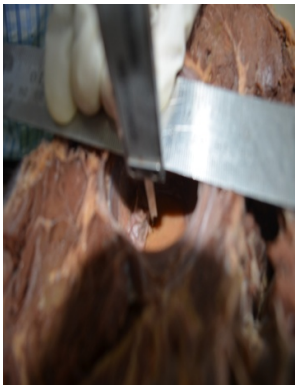
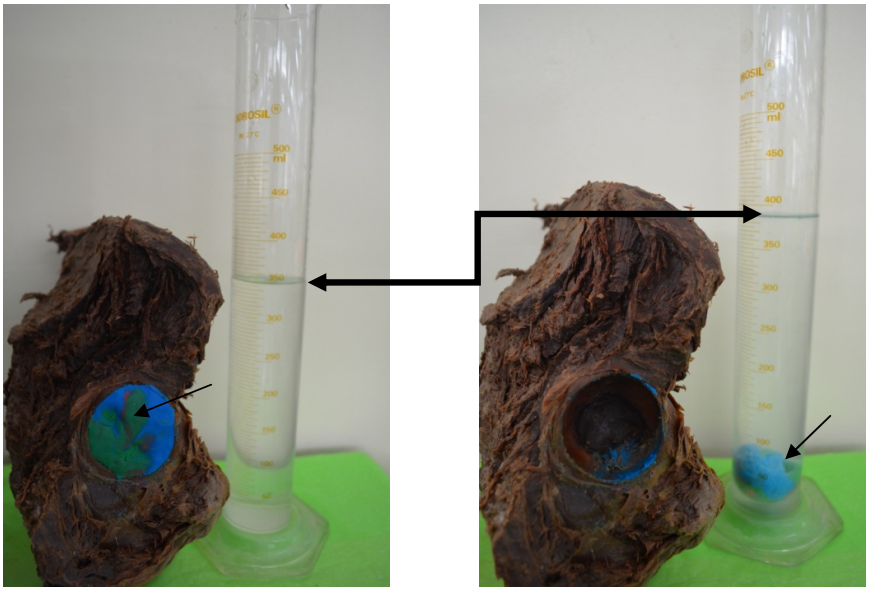


Fig 3e: Depth



1) **Diameter of the acetabulum:**

With the help of the digital vernier caliper the maximum transverse diameter of the acetabulum was measured. Maximum transverse diameter of the acetabulum is taken as the diameter of the acetabulum. **(Fig 3c)**

2**) Depth of the acetabulum.**

Maximum vertical distance from the brim of the acetabulum to the deepest point in the acetabular cavity is measured with the digital vernier caliper by placing the metallic scale horizontally over the brim of the acetabulum. The distance measured is calculated as the depth of the acetabulum. **(Fig 3d, Fig 3e)**

3) **Acetabular capacity:**

Plasticine is fixed to the size of the acetabulum cavity such that it fills the till the brim and then the plasticine is transferred to the graduated measuring cylinder filled with water. The amount of water displaced gives the capacity of the acetabulum**.(Fig 3f, Fig 3g)**

RADIOLOGICAL ASSESSMENT OF ACETABULA:

C) X RAYS:

MATERIALS:

105 (53 males, 52 females) Human pelvis X rays , Antero posterior view were obtained by PACS from the department of Orthopedics in our institution.

METHODOLOGY:

105 (53 males , 52 females), the X rays were taken in the standardized procedure of making the patient to lie in supine postion and the X rays were beamed over the pubic symphysis from a height of one meter.The nature of the X ray was confirmed as normal by discussing with the expert orthopedics surgeon and radiologist. Further methodology of acetabular parameters analysis was discussed with the Radiologist and procedures are done as the following.

S.NO	PARAMETERS	VIEW
1.	Centre edge angle. (CE angle)	Coronal view
2.	Acetabular depth. (AD)	Coronal view
3.	Acetabular angle OF Sharp.(AA)	Coronal view
4.	Acetabular roof obliquity.(ARO)	Coronal view
5.	Acetabular index angle.(AIA)	Coronal view
6.	Roof angle.(RA)	Coronal view
7.	Depth to width ratio.(DTW)	Coronal view
8.	Extrusion index.(EI)	Coronal view
9.	Lateral subluxation.(LS)	Coronal view
10.	Peak to edge distance.(PED)	Coronal view
11.	Joint space width.(JSW)	Coronal view

1) CE ANGLE: It is described as the angle between the line joining the centre of femoral head and lateral margin on the acetabular roof and the vertical line from the centre of femoral head. **(Fig 4a)**

2) ACETABULAR DEPTH:

It is the maximum distance from acetabular roof to the line joining the two lateral margins of the acetabulum.(upper margin – roof , lower margin – tear drop). **(Fig 4b)**

3) ACETABULAR ANGLE:

The angle is formed by the angle between the line connecting the left and right sides of the pelvic tear drop and a line joining the lateral edge of the acetabular roof and the inferior tip of the pelvic tear drop. **(Fig 4c)**

4) ACETABULAR ROOF OBLIQUITY:

It is defined as the angle between the line connecting the lateral edge of the acetabular roof touching the lower iliac tip of acetabular surface and a line parallel to the pelvic tear drop. **(Fig 4d)**

5) ACETABULAR INDEX ANGLE:

The horizontal line passing through the fovea of the head of the femur and a line connecting the lateral part of the acetabularlimbus and the fovea on the femoral head. **(Fig 4e)**

6) ROOF ANGLE:

It is determined by the angle inbetween the line along the lateral side of the ilium on the acetabular surface and a line parallel to the pelvic tear drop. **(Fig 4f)**

7) DEPTH TO WIDTH RATIO: Width is determined by the line joining the lateral edge of acetabulum to the pelvic tear drop.Depth is assessed by the previously mentioned method.Then the depth to width ratio is taken. **(Fig 4g)**

8) EXTRUSION INDEX:

It is a ratio between the two measurements.The horizontal distance between the vertical lines drawn through the medial and the lateral edge of the femoral head (b) and the distance between the lateral edge of femoral head and the outer edge of the acetabulum. (a) . Extrusion index is (a/a+b). **(Fig 4h)**

9) LATERAL SUBLUXATION:

The distance between the tear drop and the medial most edge of the femoral head. **(Fig 4i)**

10) PEAK TO EDGE DISTANCE:

It is the horizontal distance between the lateral edge of the acetabulum and the highest point of the sourcil. **(Fig 4j)**

11) JOINT SPACE WIDTH: (Fig 4k)

3 measurements are taken through the joint space.

1) Through fovea of the femoral head.

2) Laterallimbus of the acetabulum.

3) Lower part of acetabulum.(near the inferior tip of the tear drop.)

ACETABULAR PARAMETERS IN X RAYS

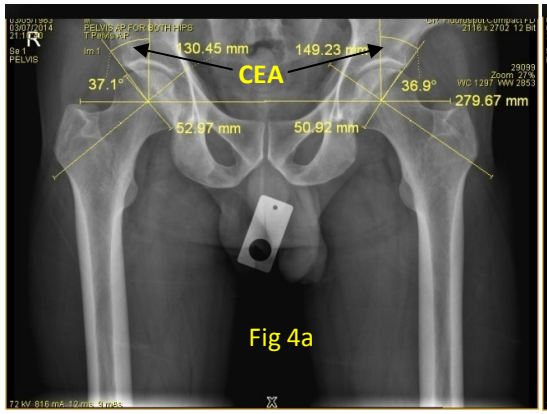


Fig 4a

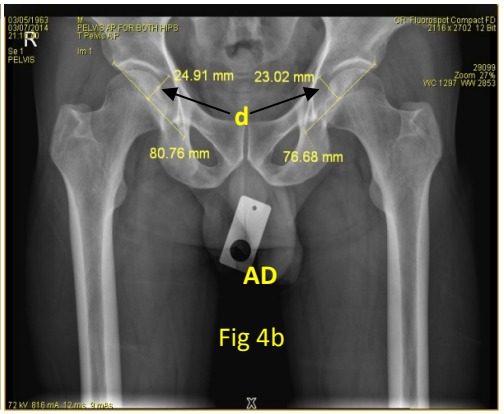


Fig 4b

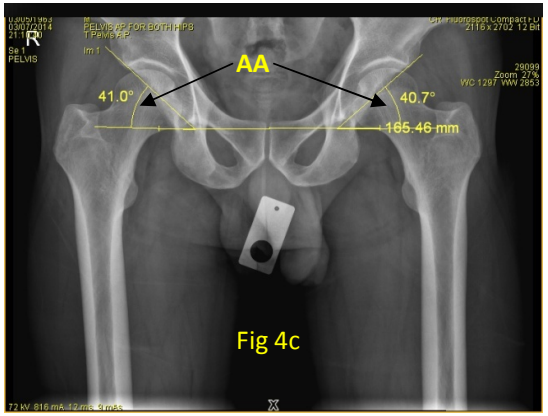


Fig 4c

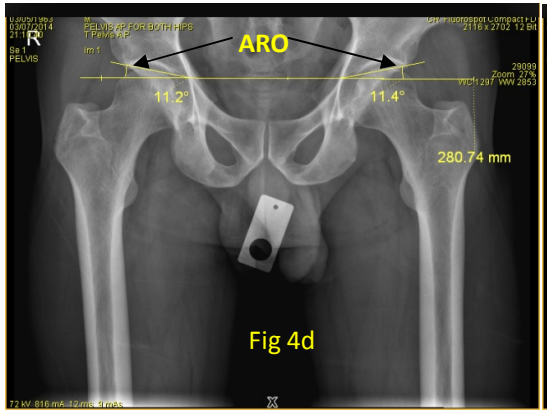


Fig 4d

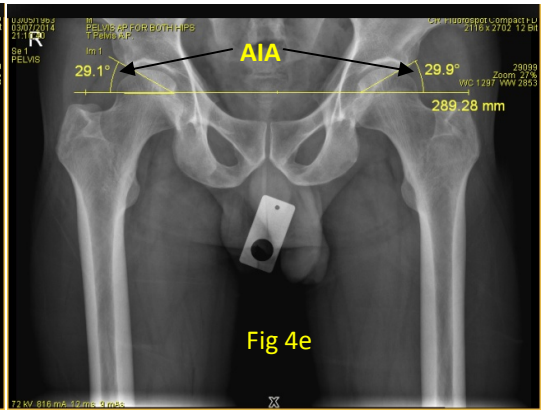


Fig 4e

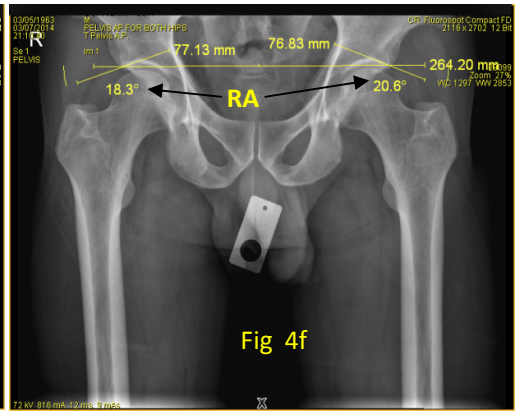


Fig 4f

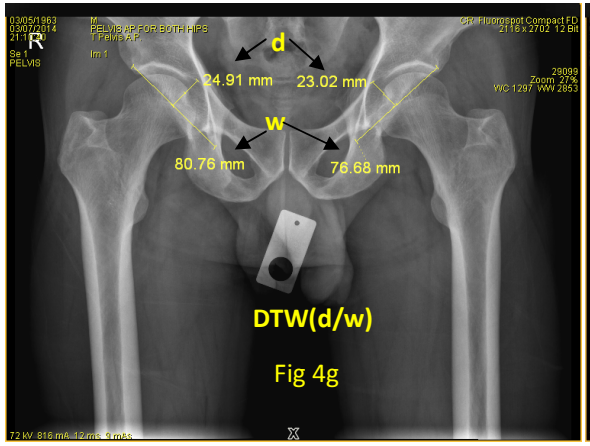


Fig 4g

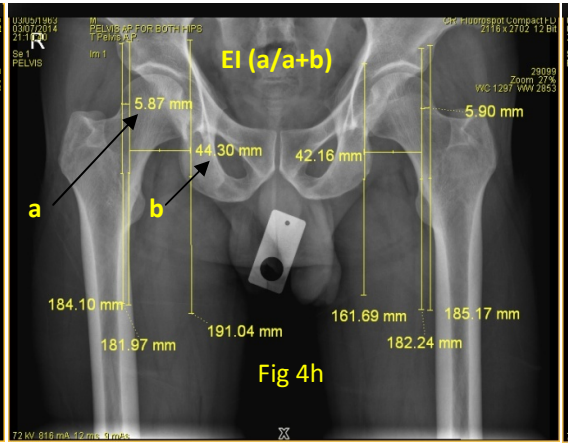


Fig 4h

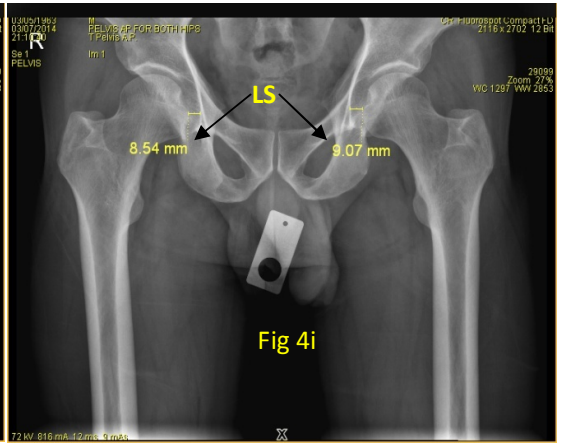


Fig 4i

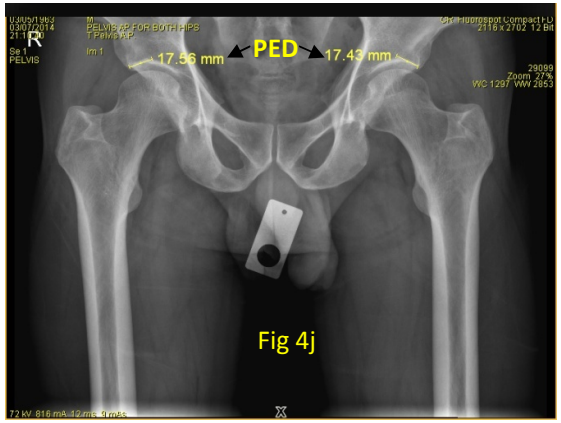


Fig 4j

Fig 4k

D) CT SCANS:

MATERIALS: 50 (24 males, 26 females) CT scans were taken from the departments of Radiology (17) and Urology (33) of our institution by using PACS.

METHODOLOGY:

50 (24 males , 26 females) CT scans of abdomen and pelvis which were taken at 5 mm thick slices in coronal and axial views by using Siemens , definition edge somatotome were taken up for the study.The report of the CT was confirmed as normal with the expert Radiologist opinion and the following parameters were adopted for acetabular CT assessment.

S.NO	PARAMETERS	VIEW
1.	Centre edge angle. (CE angle)	Coronal view
2.	Acetabular depth. (AD)	Coronal view
3.	Acetabular angle OF Sharp.(AA)	Coronal view
4.	Acetabular roof obliquity.(ARO)	Coronal view
5.	Acetabular index angle.(AIA)	Coronal view
6.	Roof angle.(RA)	Coronal view
7.	Depth to width ratio.(DTW)	Coronal view
8.	Extrusion index.(EI)	Coronal view
9.	Lateral subluxation.(LS)	Coronal view
10.	Peak to edge distance.(PED)	Coronal view
11.	Acetabular version (AV)	axial view
12.	Joint space width.(JSW)	Coronal view
13.	Anterior acetabular sector angle.(AASA)	axial view
14.	Posterior acetabular sector angle.(PASA)	axial view

1) CE ANGLE: It is described as the angle between the line joining the centre of femoral head and lateral margin on the acetabular roof and the vertical line from the centre of femoral head. **(Fig 5a)**

2) ACETABULAR DEPTH: It is the maximum distance from acetabular roof to the line joining the two lateral margins of the acetabulum. (upper margin – roof , lower margin – tear drop). **(Fig 5b)**

3) ACETABULAR ANGLE:

The angle is formed by the angle between the line connecting the left and right sides of the pelvic tear drop and a line joining the lateral edge of the acetabular roof and the inferior tip of the pelvic tear drop. **(Fig 5c)**

4) ACETABULAR ROOF OBLIQUITY:

It is defined as the angle between the line connecting the lateral edge of the acetabular roof touching the lower iliac tip of acetabular surface and a line parallel to the pelvic tear drop. **(Fig 5d)**

5) ACETABULAR INDEX ANGLE:

The horizontal line passing through the fovea of the head of the femur and a line connecting the lateral part of the acetabularlimbus and the fovea on the femoral head.**(Fig 5e)**

6) ROOF ANGLE: It is determined by the angle in-between the line along the lateral side of the ilium on the acetabular surface and a line parallel to the pelvic tear drop. **(Fig 5f)**

7) DEPTH TO WIDTH RATIO: Width is determined by the line joining the lateral edge of acetabulum to the pelvic tear drop.Depth is assessed by the previously mentioned method.Then the depth to width ratio is taken. **(Fig 5g)**

8) EXTRUSION INDEX:

It is a ratio between the two measurements.The horizontal distance between the vertical lines drawn through the medial and the lateral edge of the femoral head (b) and the distance between the lateral edge of femoral head and the outer edge of the acetabulum. (a) . Extrusion index is (a/a+b). **(Fig 5h)**

9) LATERAL SUBLUXATION:

The distance between the tear drop and the medial most edge of the femoral head. **(Fig 5i)**

10) PEAK TO EDGE DISTANCE:

It is the horizontal distance between the lateral edge of the acetabulum and the highest point of the acetabulum vertically(sourcil). **(Fig 5j)**

11) ACETABULAR VERSION:

The anterior and the posterior margins of the acetabulum should be 1.5 cm apart as measured from the centre of the femoral head in a plane that is vertical to the anterior aspect of the acetabular rim. **(Fig 5k)**

ACETABULAR PARAMETERS IN CT

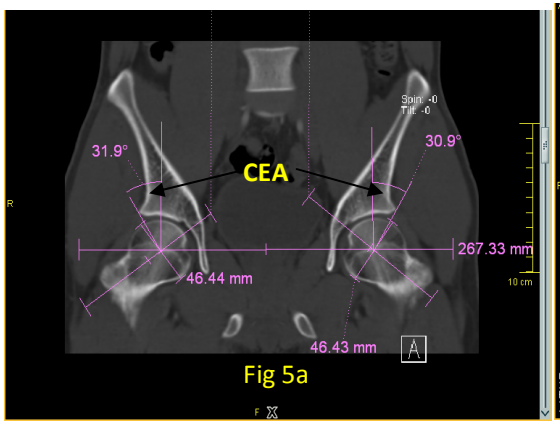


Fig 5a

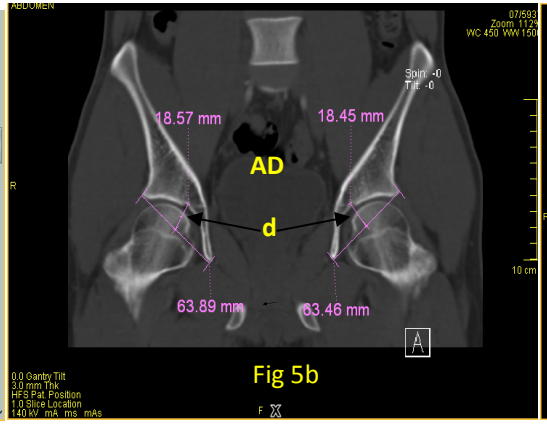


Fig 5b

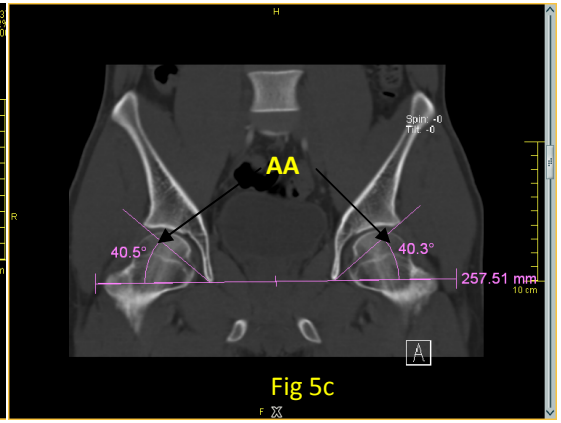


Fig 5c

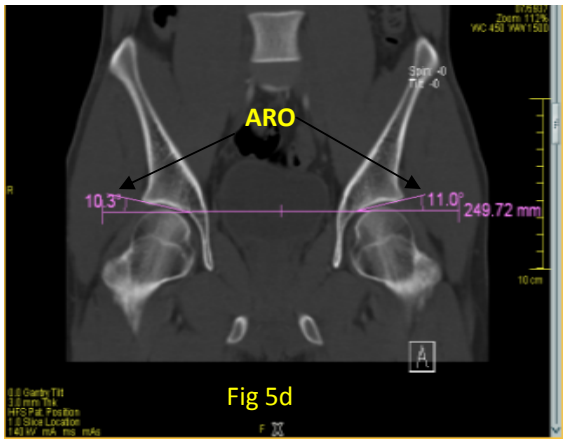


Fig 5d

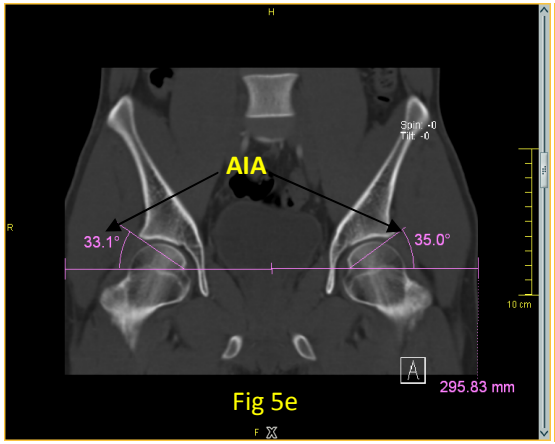


Fig 5e

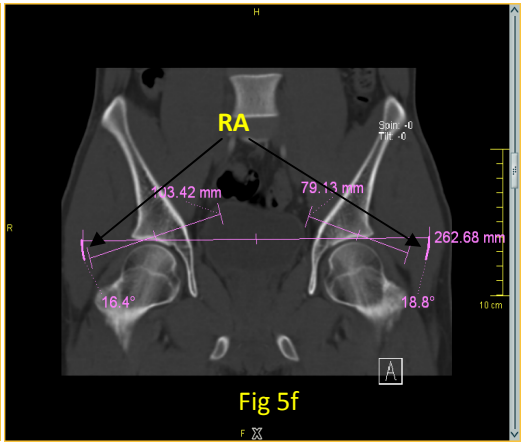


Fig 5f

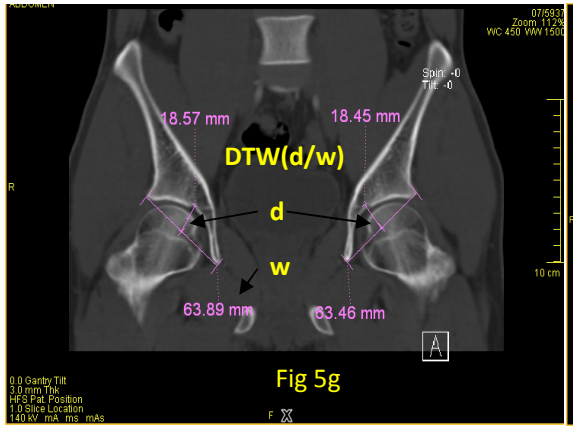


Fig 5g

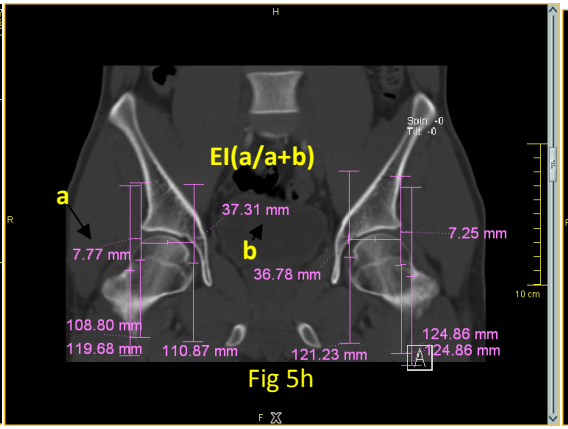


Fig 5h

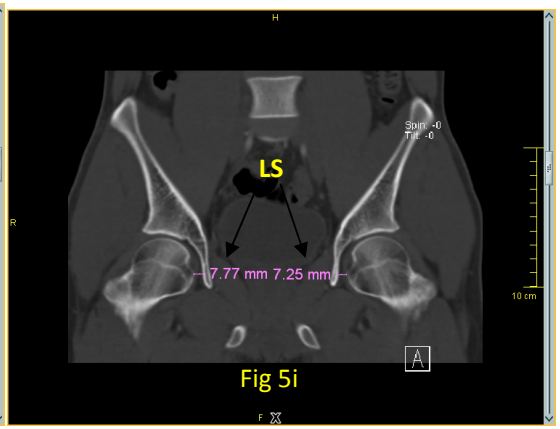


Fig 5i

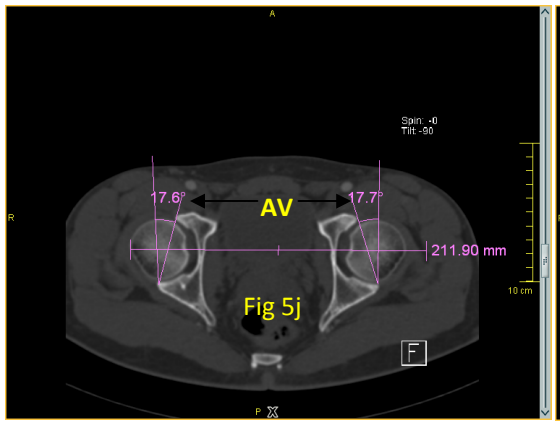


Fig 5j

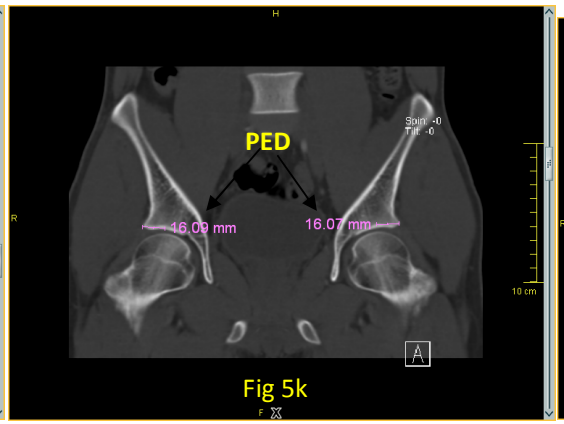


Fig 5k

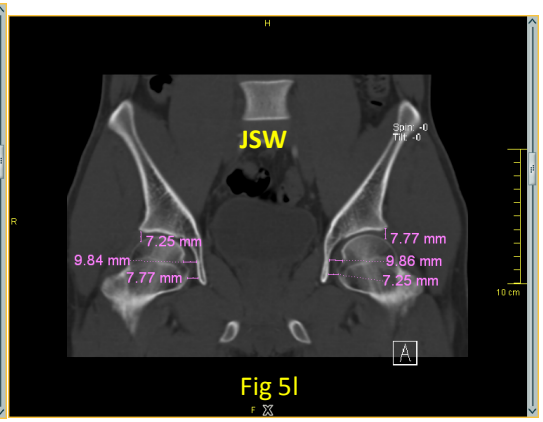
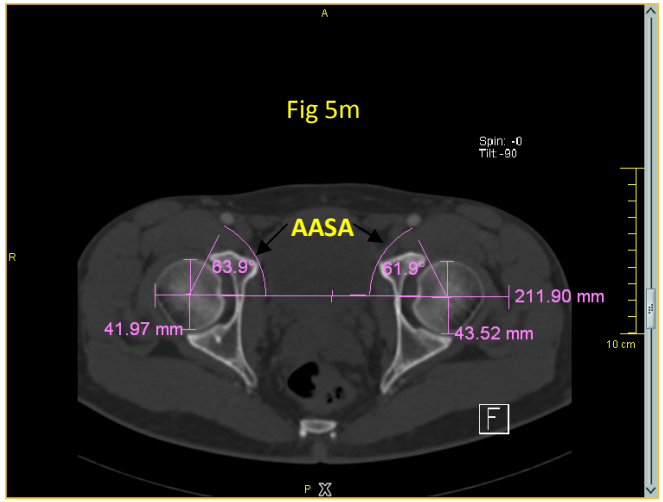
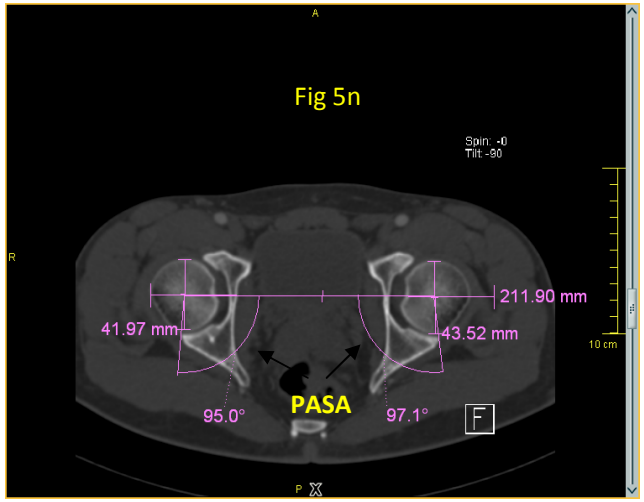


Fig 5l


A
Fig 5m
Spin: -0
Tilt: -90
AASA
63.9°
61.9°
211.90 mm
41.97 mm
43.52 mm
10 cm
R
F
P


A
Fig 5n
Spin: -0
Tilt: -90
211.90 mm
41.97 mm
43.52 mm
10 cm
95.0°
PASA
97.1°
R
F
P

12) JOINT SPACE WIDTH:

3 measurements are taken through the joint space.

1) Through fovea of the femoral head.

2) Laterallimbus of the acetabulum.

3) Lower part of acetabulum.(near the inferior tip of the tear drop.) **(Fig 5l)**

13) ANTERIOR ACETABULAR SECTOR ANGLE:

The angle between the centre line of both femoral heads and the line from centre towards the anterior margin of acetabulum. **(Fig 5m)**

14) POSTERIOR ACETABULAR SECTOR ANGLE:

The angle between the centre line of both femoral heads and the line from centre towards the posterior margin of acetabulum. **(Fig 5n)**

E) FETUSES:

MATERIALS:

1) 30 fetuses (15 males, 15 females) which were obtained from the Obstetrics department of our institution was used up for the study.
2) Two marker needles.
3) Digital vernier caliper.

ACETABULAR PARAMETERS IN FETUS

Fig 6a: Incision below the inguinal ligament. (24 weeks aborted fetus)

Fig 6b: Acetabulum exposed after dividing the ligament of head of the femur and removing the fibrous capsule. (24 weeks aborted fetus)

Fig 6c

Fig 6d

Fig 6c, 6d : Measurement of the Diameter of the acetabulum (32 weeks aborted fetus)

Fig 6e

Fig 6f

Fig 6e, 6f : Measurement of the Depth of the acetabulum (32 weeks aborted fetus)

METHODOLOGY:

30 fetuses (15 males and 15 females) were grouped under the age criteria from 12 to 40 weeks as 12 to 20, 21 to 30, and 31 to 40. Age was assessed by using crown rump length measurement correlated with ultrasound measured gestational age. The lowest week was 12 and the highest was 38. Fetuses were also grouped under trimester (second and third trimester).Fetuses were analyzed for structural defects as mentioned earlier, the acetabulum was dissected out after removing the muscles and the capsule (labrum was preserved). **(Fig 6a, 6b)**. By using two marker needles and digital vernier caliper the following measurements were made out:

1) Diameter of the acetabulum: (Width of the acetabulum)

The greatest transverse diameter is taken with the marker needle and measured using digital vernier caliper. The measurement obtained is taken as the diameter of the acetabulum.(a1). **(Fig 6c, 6d)**

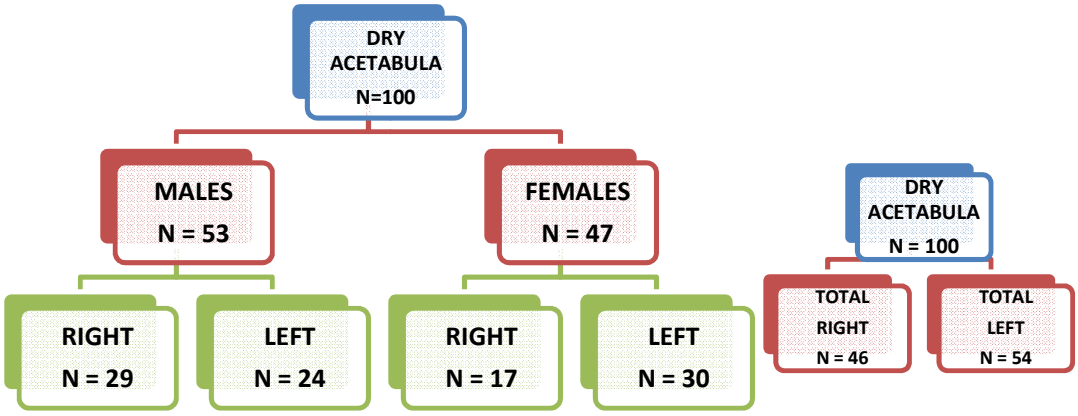
2) Depth of the acetabulum:

One of the marker needle is kept across the diameter of the acetabulum, the other marker needle is placed vertically downwards at right angles to the first needle, till it reaches the floor of the acetabulum. The distance in the needle is measured with vernier caliper and is taken as the depth of the acetabulum.(a2) **(Fig 6e , 6f)**

3) **The shape of acetabulum** in different age groups is assessed by the depth to width (diameter) percentage, which is calculated as a2/a1 * 100 (Depth / width * 100).If it is less than than 50 % then the acetabular cavity is getting less hemispherical, favouring increased mobility, increasing the chance of congenital dislocation.

OBSERVATION AND RESULTS

A) DRY HIP BONES (TOTAL NUMBER OF HIP BONES : 100)



SEX DETERMINATION:	**SIDE DETERMINATION:**
Total number of male hip bones: 53.	Total number of right sided acetabulum : 46.
Total number of female hip bones: 47.	Total number of left sided acetabulum : 54.

SEX AND SIDE DETERMINATION:

Total number of right sided male acetabulum : 29.	Total number of right sided female acetabulum : 17.
Total number of left sided male acetabulum : 24.	Total number of left sided male acetabulum : 30.

ACETABULAR PARAMETERS

Diameter of the acetabulum , Depth of the acetabulum , Capacity of the acetabulum , Morphology of the anterior acetabular ridge.

1)DIAMETER OF THE ACETABULUM:

The average diameter of the acetabulum was about 50.75 ± 2.69 mm , 46.07 ± 3.02 mm , 49.07 ± 3.55 mm , 48.16 ± 3.77 mm , 50.82 ± 2.76 mm , 50.66 ± 2.66 mm , 45.91 ± 2.47 mm , 46.16 ± 3.33 mm in males , females , right side , left side , right side of the males , left side of the males , right side of the females and left side of the females respectively. Among males and females, the males had the highest mean diameter of 50.75 ± 2.69 mm, comparing to left side the right side of the acetabulum marked a highest value of 49.07 ± 3.55 mm. The right side acetabulum of the males ranged a higher value of 50.82 ± 2.76 mm than left side of the acetabulum. In females, the left side diameter of acetabulum 46.16 ± 3.33 mm averaged more than the right side of the acetabulum.(**Table 5) (Graph 1).**

2) DEPTH OF THE ACETABULUM:

The average depth of the acetabulum was about 24.30 ± 2.67 mm , 21.42 ± 2.39 mm, 22.58 ± 2.91 mm , 23.26 ± 2.91 mm , 23.80 ± 2.58 mm , 24.90 ± 2.71 mm , 20.50 ± 2.21 mm, 21.95 ± 3.33 mm in males , females , right side , left side , right side of the males , left side of the males , right side of the females and left side of the females respectively. Among males and females, the males had the highest mean depth of 24.30 ± 2.69 mm, comparing to right side the left side of the acetabulum marked a highest value of 23.26 ± 2.91mm. The left side acetabulum of the males ranged a higher value (24.90 ± 2.71mm) than right side of the acetabulum. In females the left side acetabulum (21.95± 3.33 mm) averaged more than the right side of acetabulum.(**Table 6) (Graph 2)**

3) CAPACITY OF THE ACETABULUM :

The average capacity of the acetabulum was about 36.21 ± 11.47 ml, 25.34 ± 6.98 ml, 31.28 ± 9.16 ml, 30.95 ± 12.47, 35.16 ± 7.58, 37.49 ± 14.99, 24.68 ± 7.87, 25.72 ± 6.53 in males, females, right side, left side, right side of the males, left side of the males, right side of the females and left side of the females respectively. Among males and females, the males had the highest mean depth of 36.21 ± 11.47 ml, comparing to left side, the right side of the acetabulum marked a highest value of 31.28 ± 9.16 ml. The left side acetabulum of the males ranged a higher value (37.49 ± 14.99 ml) than right side of the acetabulum. In females the left side acetabulum (25.72± 6.53 ml) averaged more than the right side of acetabulum.(**Table 7) (Graph 3)**

4)TYPES OF ANTERIOR ACETABULAR RIDGE (TABLE 4):

The curved type of anterior acetabular ridge was seen more in females (30) than males (20). In the left side of the acetabulum, the curved type was 29 in number, on comparing with 21on the right side. The right side acetabulum of the males had 11 curved type which is highest on comparing with the left side. The left side acetabulum of the females has more curved type (20) than the right side of the acetabulum. The least common type is the straight. The straight type was 5 in males, 8 in females. The right side had 5 stright type where as the left side had 8. The right side of the acetabulum in males had 6 while the left side had 8. The left side acetabulumof the females has 2 straight types and 1 was present on the right side of the females. The angular type of anterior acetabular ridge was seen more in males (14) than females

(3). In the left side of the acetabulum, the curved type was 10 in number on comparing with 7 on the right side. The right side acetabulum of the males had 11 curved type which is highest on comparing with the left side. The left side acetabulum of the females has more curved type (20) than the right side of the acetabulum. Irregular type was distributed as 14, 6, 13, 7, 10, 4, 3 and 3 in males, females, right, left, right males, left males, right females and left females respectively**. (Table 8) (Graph 4)**

DIAMETER, DEPTH & CAPACITY OF THE ACETABULUM (total):

On observing the total number of acetabula of the hip bones, the mean value of the diameter, depth and the capacity of the 100 human dry hip bones were 48.55 ± 3.68 mm , 22.94 ± 2.91 mm and 31.10 ± 11.02mm respectively. **(Table 9) (Graph 5).**

MORPHOLOGY OF ANTERIOR ACETABULAR RIDGE:

Curved (50) type of anterior acetabular ridge predominated the morphology of anterior acetabular ridge while comparing with irregular (20), angular (17) and the least presented type was straight (13). **(Table 10) (Graph 6).**

DIAMETER OF THE ACETABULUM (TABLE 5)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 53)	44.60	57.51	50.75	2.69
TOTAL FEMALES (n =47)	38.22	52.06	46.07	3.02
TOTAL RIGHT (n = 46)	41.88	57.51	49.07	3.55
TOTAL LEFT(n =54)	38.22	56.98	48.16	3.77
RIGHT MALES(n = 29)	46.16	57.51	50.82	2.76
LEFT MALES (n = 24)	44.60	56.98	50.66	2.66
RIGHT FEMALES(n = 17)	41.88	50.86	45.91	2.47
LEFT FEMALES(n = 30)	38.22	52.06	46.16	3.33

DEPTH OF THE ACETABULUM (TABLE 6)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 53)	19.93	32.73	24.30	2.67
TOTAL FEMALES (n =47)	15.95	28.12	21.42	2.39
TOTAL RIGHT (n = 46)	15.95	29.03	22.58	2.91
TOTAL LEFT(n =54)	16.70	32.73	23.26	2.91
RIGHT MALES(n = 29)	19.93	29.03	23.80	2.58
LEFT MALES (n = 24)	21.67	32.73	24.90	2.71
RIGHT FEMALES(n = 17)	15.95	24.92	20.50	2.21
LEFT FEMALES (n= 30)	28.12	16.70	21.95	3.33

CAPACITY OF THE ACETABULUM (TABLE 7)

GROUPS	MINIMUM(ml)	MAXIMUM(ml)	MEAN(ml)	S.D(ml)
TOTAL MALES (n = 53)	20.00	90.00	36.21	11.47
TOTAL FEMALES (n =47)	10.00	45.00	25.34	6.98
TOTAL RIGHT (n = 46)	15.00	50.00	31.28	9.16
TOTAL LEFT(n =54)	10.00	90.00	30.95	12.47
RIGHT MALES(n = 29)	20.00	50.00	35.16	7.58
LEFT MALES (n = 24)	20.00	90.00	37.49	14.99
RIGHT FEMALES(n = 17)	15.00	45.00	24.68	7.87
LEFTFEMALES(n = 30)	10.00	44.25	25.72	6.53

TYPES OF ANTERIOR ACETABULAR RIDGE (TABLE 8)

GROUPS	CURVED	STRAIGHT	ANGULAR	IRREGULAR
TOTAL MALES (n = 53)	20	05	14	14
TOTAL FEMALES (n =47)	30	08	03	06
TOTAL RIGHT (n = 46)	21	05	07	13
TOTAL LEFT(n =54)	29	08	10	07
RIGHT MALES(n = 29)	11	02	06	10
LEFT MALES (n = 24)	09	03	08	04
RIGHT FEMALES(n = 17)	10	03	01	03
LEFTFEMALES(n = 30)	20	05	02	03

TOTAL (n = 100)

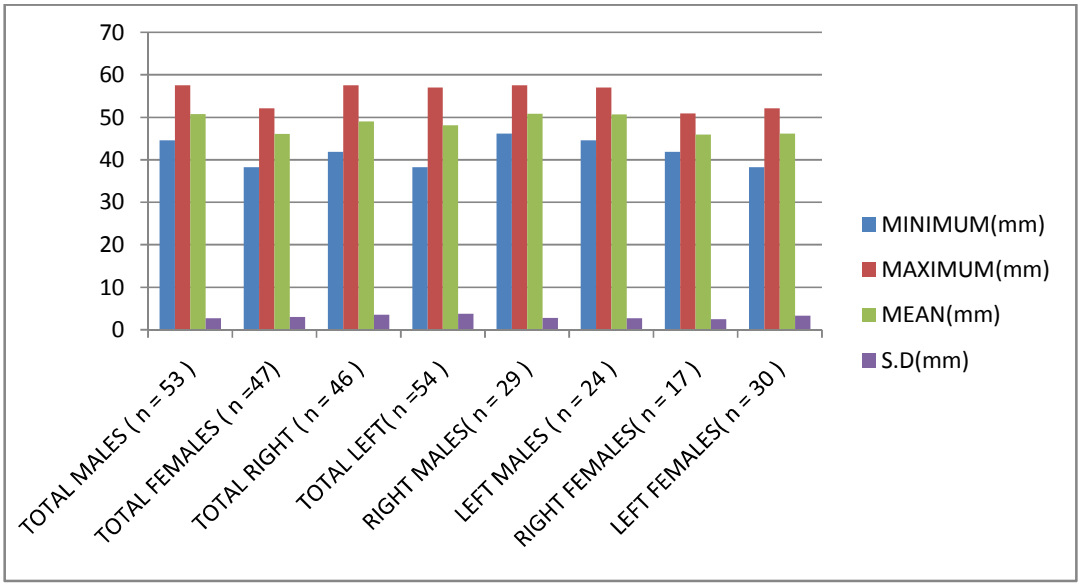
DIAMETER , DEPTH & CAPACITY OF THE ACETABULUM (Table 9)

S.NO	PARAMETERS	MINIMUM	MAXIMUM	MEAN	S.D
1.	**Diameter**	38.22 **(mm)**	57.51 **(mm)**	48.55 **(mm)**	3.68 **(mm)**
2.	**Depth**	15.59 **(mm)**	32.73 **(mm)**	22.94 **(mm)**	2.91 **(mm)**
3.	**Capacity**	10.00 **(ml)**	90.00 **(ml)**	31.10 **(ml)**	11.02 **(ml)**

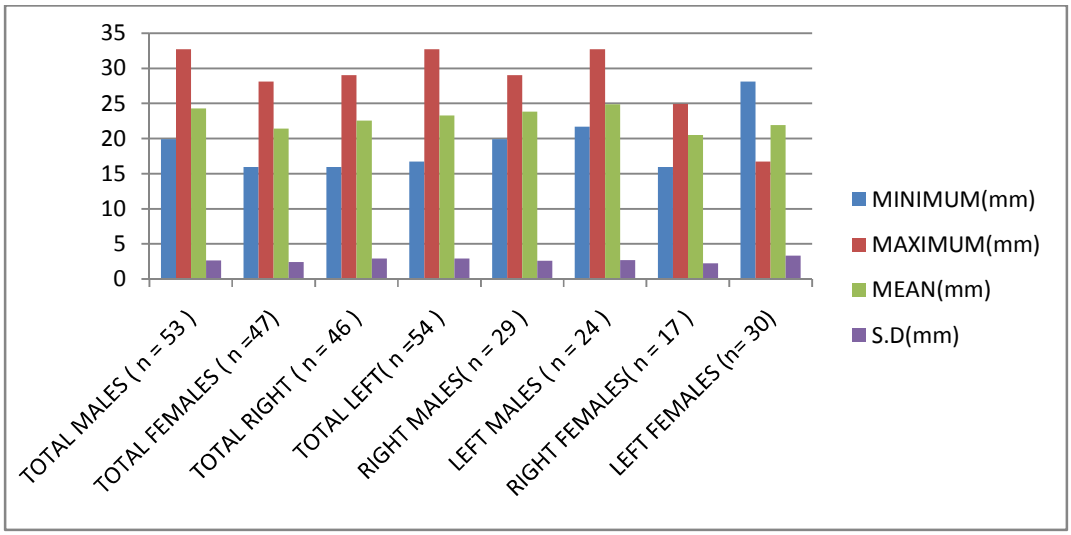
MORPHOLOGY OF ANTERIOR ACETABULAR RIDGE:(n = 100)(TABLE 10)

S.NO	TYPES	TOTAL NUMBER
1.	**Curved**	50
2.	**Straight**	13
3.	**Angular**	17
4.	**Irregular**	20

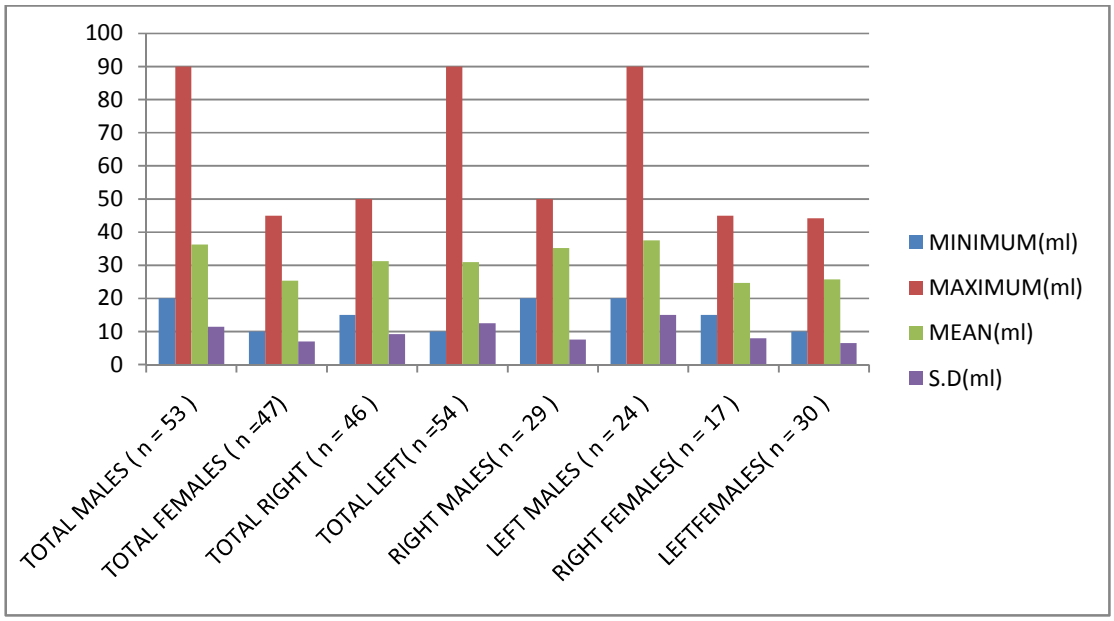
GRAPHS FOR DRY ACETABULAR PARAMETERS)



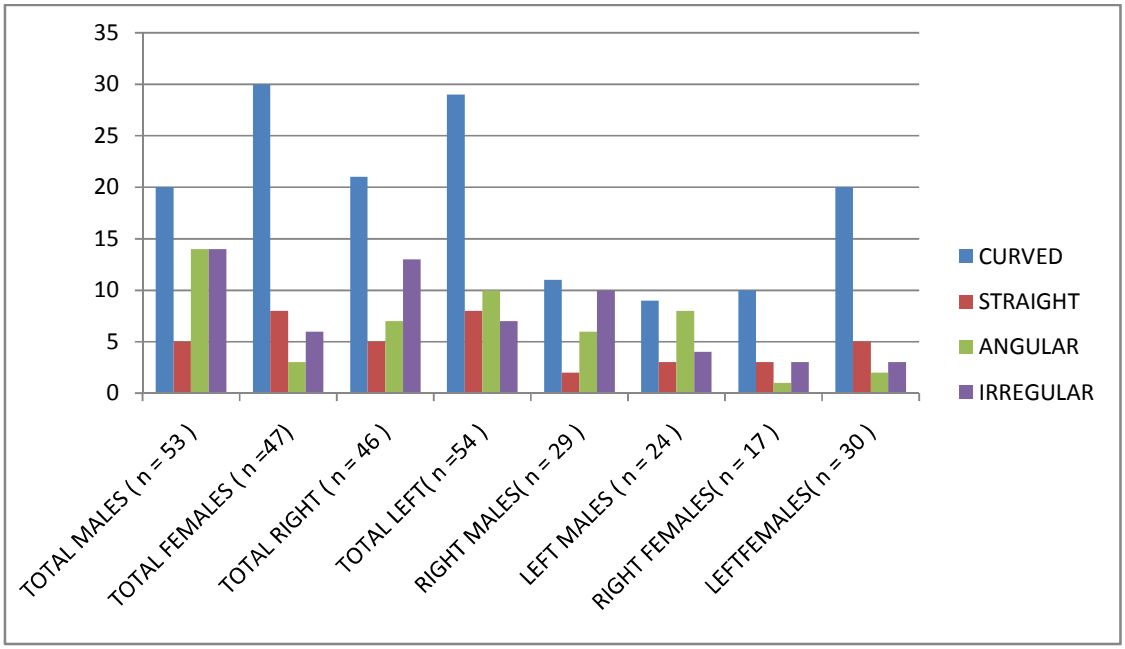
(Graph 1 : The min, max, mean and S.D of the diameter of acetabulum in various groups).



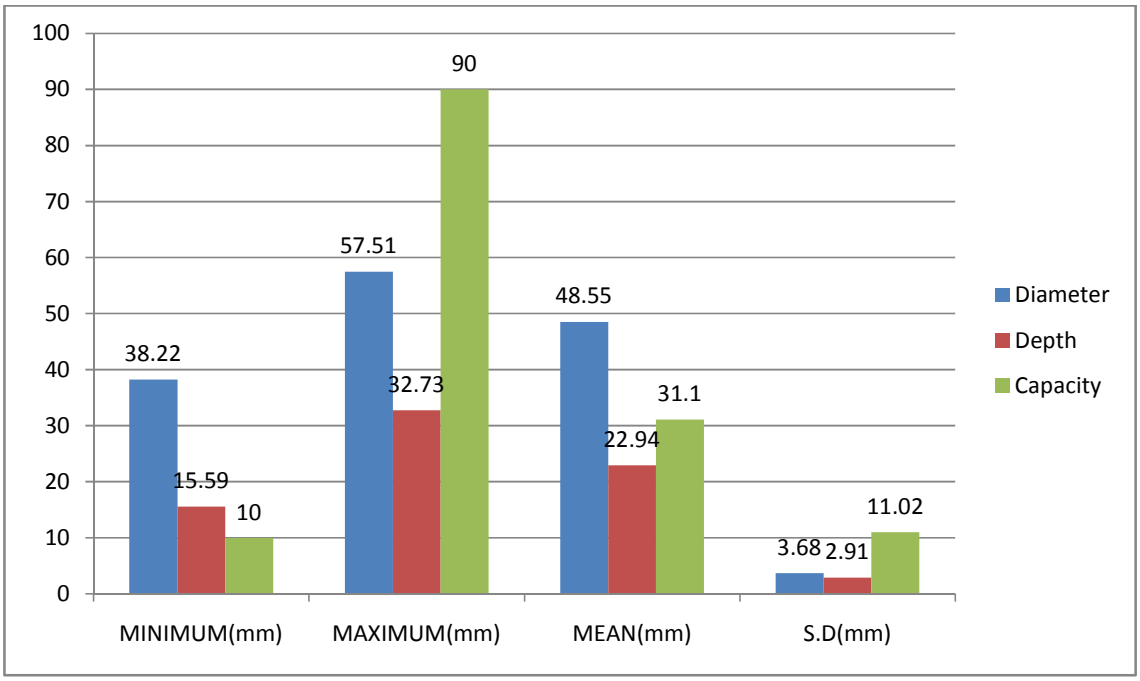
(Graph 2: The min, max, mean and S.D. values of depth of the acetabulum in various groups).



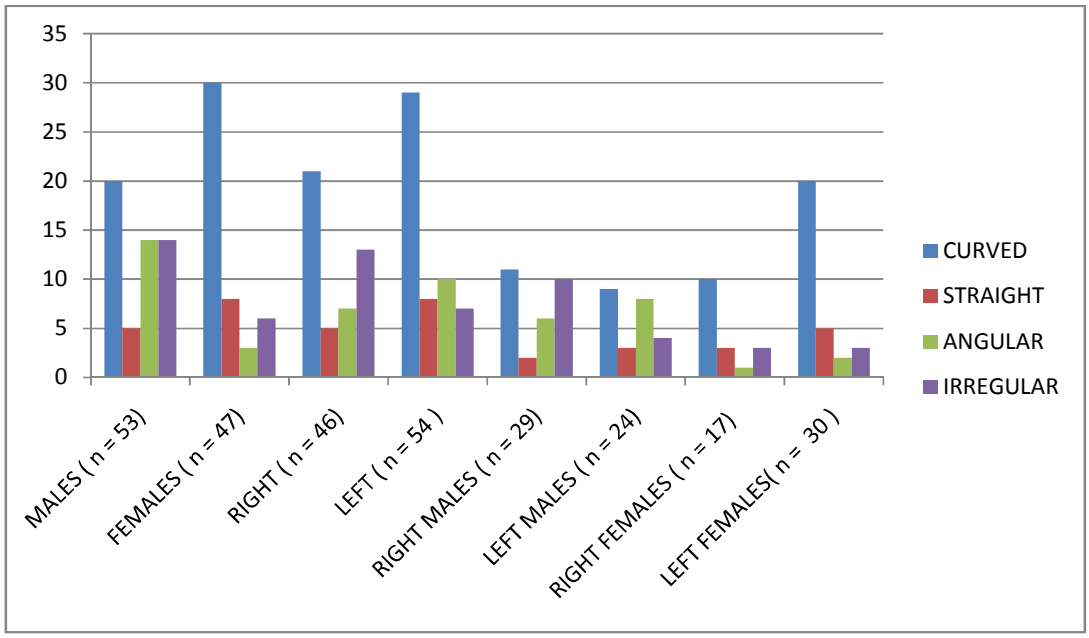
(Graph 3: The readings of capacity of the acetabulum in various groups)



(Graph 4 : The distribution of the types of the anterior acetabular ridge)

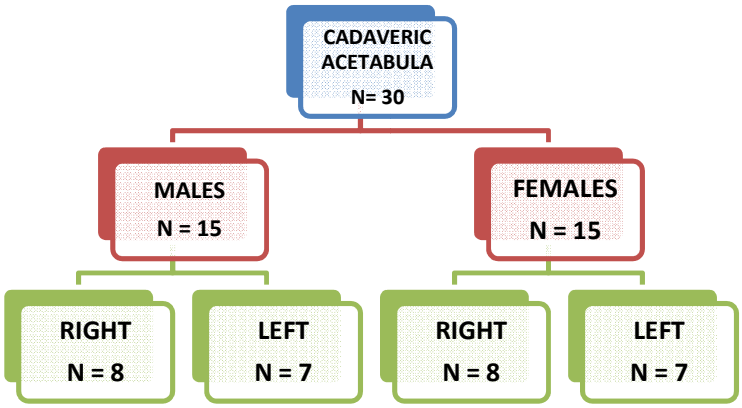


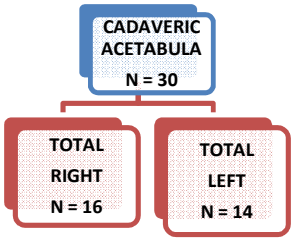
(Graph 5: The dry acetabular parameters with its min , max , mean,S.D)



(Graph 6 :The distribution of the morphology of anterior acetabular ridge.)

B)CADAVERIC ACETABULA (TOTAL NUMBER OF ACETABULUM = 30)





SEX DETERMINATION:	**SIDE DETERMINATION:**
Total number of male hip bones: 15. Total number of female hip bones: 15.	Total number of right sided acetabulum : 16. Total number of left sided acetabulum : 14.

SEX AND SIDE DETERMINATION:

Total number of right sided male acetabulum : 8. Total number of left sided male acetabulum : 7.	Total number of right sided female acetabulum : 8. Total number of left sided male acetabulum : 7.

ACETABULAR PARAMETERS:

1) Diameter of the acetabulum. 2) Depth of the acetabulum. 3) Capacity of the acetabulum.

1) DIAMETER OF THE ACETABULUM:

The average diameter of the acetabulum in the cadaveric males, females, right side acetabulum , left side acetabulum , right side of the male acetabulum left side of the female acetabulum , right side of the female acetabulum and left side of the female acetabulum were 44.44 ± 2.83 mm, 40.35 ± 2.68 mm, 41.72 ± 3.56 mm, 43.16 ± 3.20 mm, 43.67 ± 3.41 mm, 45.32 ±1.84 mm, 39.77 ± 2.60 mm and 41.01 ± 2.82 mm respectively**.(Table 11) (Graph 7).** The mean diameter was more in males, left, left males and left females when compared to that of females, right, right males and right females respectively.

2) DEPTH OF THE ACETABULUM:

On assessing the mean depth of the acetabulum , the results obtained in males, females, right side of the acetabula, left side of the acetabula, right side of the male and left side of the female acetabula were 30.77 ± 3.23 mm, 27.79 ± 2.29 mm, 29.27 ± 3.59 mm, 29.29 ± 2.67 mm, 31.11 ± 4.10 mm, 30.39 ± 2.13, 27.44 ± 1.80 mm and 28.2 ± 2.84 mm respectively**.(Table 12) (Graph 8).** The mean depth was more in males, left side, right side of males and left side of females when compared with females, right side, left side of males and right side of females respectively.

3)CAPACITY OF THE ACETABULUM :

The average capacity of the acetabulum in the males , females , right side , left side , right side of the males , left side of the males , right side of the females and left side of the females were 34.15 ± 5.96 ml, 24.17 ± 4.60 ml ,29.36 ± 7.66 ml , 28.93 ± 7.12 ml, 33.57 ± 5.56 ml, 33.57 ± 5.56 ml, 24.06 ± 4.21 ml and 24.29 ± 5.34 ml

respectively**.(Table 13) (Graph 9).** The average capacity of the acetabulum was more in males, right side, left side of the females than the females, left side, and right side of the females respectively. Both the right and left side of the males were equal on both the sides.

TOTAL DIAMETER , DEPTH & CAPACITY OF THE ACETABULUM :

On observing the 30 cadaveric specimens of human acetabula, we found the maen value of diameter and depth of the acetabula were 42.39 ± 3.41mm and 29.28 ± 3.14 mm respectively. 29.16 ± 7.28 ml was the mean capacity of the 30 cadaveric acetabulum. **(Table 14) (Graph 10).**

DIAMETER OF THE ACETABULUM (TABLE 11)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n= 15)	38.53	48.84	44.44	2.83
TOTAL FEMALES (n = 15)	34.75	45.59	40.35	2.68
TOTAL RIGHT (n = 16)	34.75	48.84	41.72	3.56
TOTAL LEFT (n = 14)	37.16	47.68	43.16	3.20
RIGHT MALES (n = 8)	38.53	48.84	43.67	3.42
LEFT MALES (n = 7)	42.70	47.68	45.32	1.84
RIGHT FEMALES(n=8)	34.75	42.19	39.77	2.60
LEFT FEMALES (n = 7)	37.16	45.59	41.01	2.82

DEPTH OF THE ACETABULUM (TABLE 12)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n= 15)	25.15	37.48	30.77	3.23
TOTAL FEMALES (n = 15)	24.17	33.40	27.79	2.29
TOTAL RIGHT (n = 16)	24.54	37.48	29.27	3.59
TOTAL LEFT(n = 14)	24.27	33.40	29.29	2.67
RIGHT MALES (n = 8)	25.15	37.48	31.11	4.10
LEFT MALES (n = 7)	27.89	32.68	30.39	2.13
RIGHT FEMALES(n=8)	24.54	30.25	27.44	1.80
LEFT FEMALES (n = 7)	24.17	33.40	28.20	2.84

CAPACITY OF THE ACETABULUM (TABLE 13)

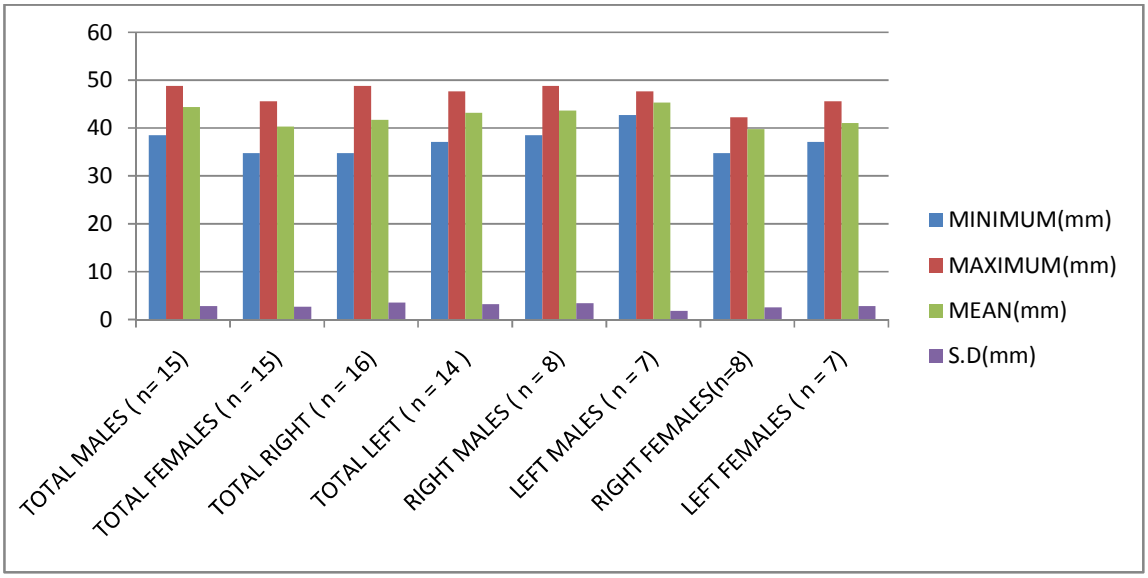
GROUPS	MINIMUM(ml)	MAXIMUM(ml)	MEAN(ml)	S.D(ml)
TOTAL MALES(n= 15)	25.00	45.00	34.15	5.96
TOTAL FEMALES (n = 15)	20.00	35.00	24.17	4.6
TOTAL RIGHT (n = 16)	20.00	45.00	29.36	7.66
TOTAL LEFT (n = 14)	20.00	40.00	28.93	7.12
RIGHT MALES (n = 8)	25.00	45.00	33.57	5.56
LEFT MALES (n = 7)	25.00	40.00	33.57	5.56
RIGHT FEMALES(n=8)	20.00	30.00	24.06	4.21
LEFT FEMALES (n = 7)	20.00	35.00	24.29	5.34

TOTAL (n = 30) (Table 14)

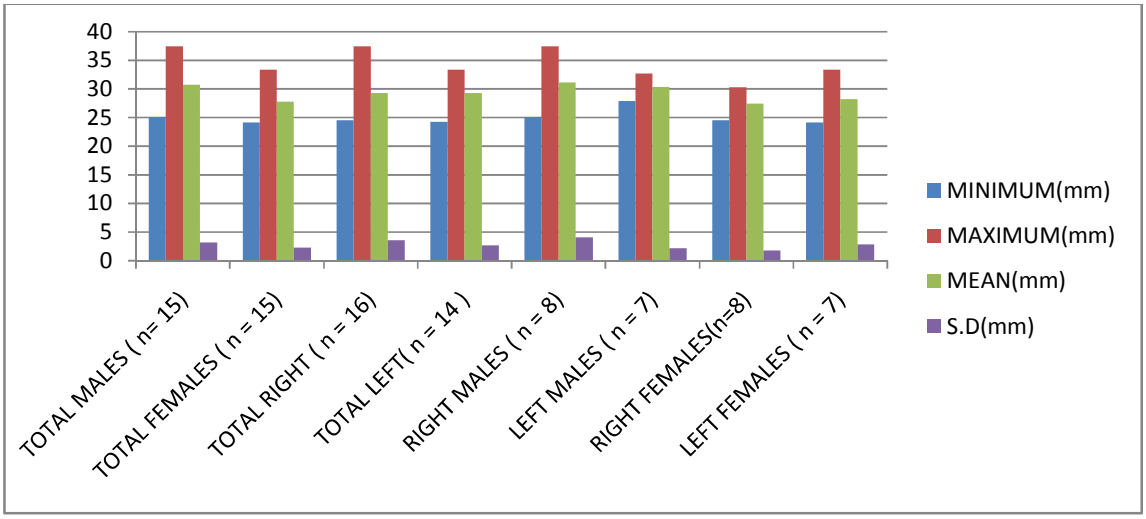
DIAMETER, DEPTH & CAPACITY OF THE ACETABULUM:

S.NO	PARAMETERS	MINIMUM	MAXIMUM	MEAN	S.D
1.	**Diameter (mm)**	34.75	48.84	42.39	3.41
2.	**Depth (mm)**	24.17	37.48	29.28	3.14
3.	**Capacity (ml)**	20.00	45.00	29.16	7.28

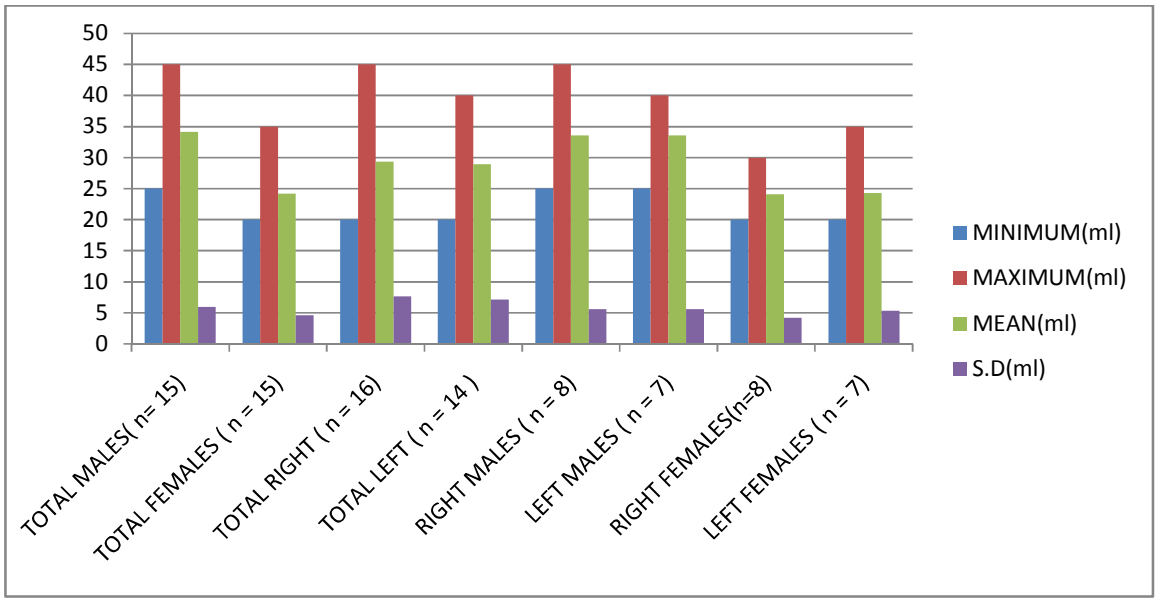
(GRAPHS FOR CADAVERIC ACETABULARPARAMETERS)



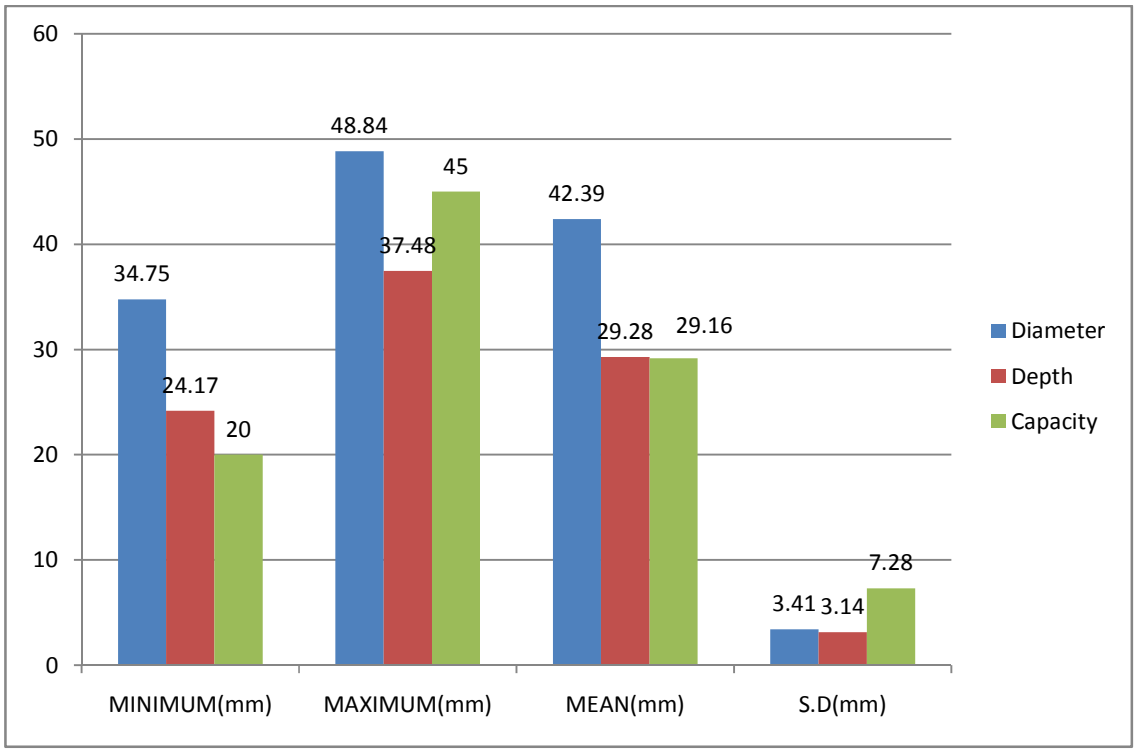
(Graph 7 : The mean diameter of the acetabulum in various groups with its range of values.)



(Graph 8 : The min, max, mean, S.D of the depth of the cadaveric acetabula in various groups.)

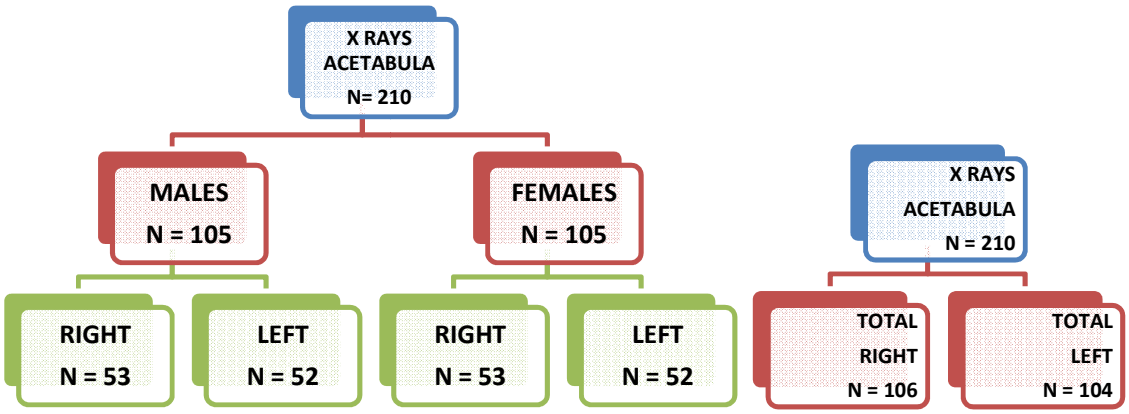


(Graph 9 : Capacity of the acetabulum in various groups with min , max ,mean and S.D.)



(Graph 10 : The measurements of diameter, depth and the capacity of cadaveric acetabula.)

C) X RAYS: (105) : (TOTAL - 210 ACETABULA.)



SEX DETERMINATION:	**SIDE DETERMINATION:**
Total number of male pelvis : 53(106 acetabula)	Total number of right sided acetabulum : 105.
Total number of female pelvis: 52. (104 acetabula)	Total number of left sided acetabulum : 105.

SEX AND SIDE DETERMINATION:

Total number of right sided male acetabulum : 53.	Total number of right sided female acetabulum : 52.
Total number of left sided male acetabulum : 53.	Total number of left sided male acetabulum : 52.

ACETABULAR PARAMETERS

1)CE angle	2)AD	3)AA	4)ARO
5)AIA	6)RA	7)DTW	8)EI
9)LS	10)PED	11)JSW	

1) CENTRE EDGE (CE) angle:

The mean acetabular CE angle values measured in pelvic Anteroposterior X rays were 42.89 ± 3.02 ˚, 41.91 ± 2.52˚, 42.33 ± 2.68˚, 42.48 ± 2.97˚, 42.79 ± 3.00˚, 43 ± 3.08˚, 41.86 ± 2.25˚, 41.95 ± 2.79˚ in males, females, right side, left side, right side of the males, left side of the males, right side of the females and left side of the females respectively**.(Table 15) (Graph 11).** Males, left side, left side of the males and left side of the females outnumbered in average, with their counterparts.

2)ACETABULAR DEPTH :

The average measurements of acetabular depth in males ,females , right side , left side, right side of the males , left side of the males, right side of the males, right side of the females, left side of the females were 21.92 ± 2.61mm, 19.84 ± 1.67 mm, 21.07 ± 2.42 mm, 20.71 ± 2.43 mm, 21.99 ± 2.46 mm, 21.84 ± 2.68 mm, 20.21 ± 1.87 mm, 19.55 ± 1.42 mm respectively**.(Table 16) (Graph 12).**The mean values of males, right, right side of the males and right side of the females were more than that of females, left, left side of the males and left side of the females respectively.

3)ACETABULAR ANGLE :

The results based on the observations made on the various groups such as males, females, right side, left side, right side acetabulum of males, left side acetabulum of males, right side acetabulum of females and left side acetabulum of the females for mean acetabular angle were 36.06 ± 2.06˚, 36.25 ± 3.24˚, 36.37 ± 3.08˚, 36.13 ± 3.12˚, 36.08 ± 2.95˚, 36.04 ± 3.00˚, 36.68 ± 3.26˚ and 36.22 ± 3.26˚ respectively**.(Table 17) (Graph 13).** In females, right side, right side of the males,

right side of the females the values of average acetabular angle were more than that of the males, left side, left side of the males and left side of the females respectively.

4) ACETABULAR ROOF OBLIQUITY :

9.69 ± 2.07 ˚, 9.64 ± 1.72˚, 9.82 ± 1.83˚, 9.51 ± 1.96˚, 9.87 ± 2.06˚, 9.52 ± 2.13˚, 9.77 ± 1.66˚ and 9.50 ± 1.79˚ were the results of males, females, right side, left side, right side acetabulum of the males, left side acetabulum of the males, right side of the females and left side of the females respectively while measuring the acetabular roof obliquity**.(Table 18) (Graph 14).** Males, right side, right side of the males, right side of the females average outnumbered females, left side, left side of the females and left side of the females respectively.

5) ACETABULAR INDEX ANGLE:

The mean acetabular index angle of various groups such as males, females, right side, left side, right side of the males, left side of the males , right side of the females and the left side of the females were 24.91 ± 4.09˚, 25.08 ± 3.18˚, 24.95 ± 3.88˚, 25.04 ± 3.45˚, 24.9 ± 4.34˚, 24.92 ± 3.87˚, 25 ± 3.39˚ and 25.15 ± 2.99˚ respectively**.(Table 19) (Graph 15).** The average values of females, left side, left side of the males, left side of the females were more than that of the males, right side , right side of the females and right side of the females respectively.

6)ROOF ANGLE:

The mean values of the acetabular roof angle were 19.55 ± 2.00˚, 17.91 ± 1.84˚, 18.90 ± 2.02˚, 18.58 ± 2.15˚, 19.9 ± 1.79˚, 19.2 ± 2.14˚, 17.88 ± 1.73˚ and 17.93 ± 1.97˚ in males, females, right side, left side, right side of the males, left side of the males, right side of the females and left side of the females respectively. **(Table 20) (Graph 16)**.The mean values of males, right side, right side of the males, left side of the females were more than that of the females, left side, left side of the males and left side of the females respectively.

7)DEPTH TO WIDTH RATIO :

The mean values of the depth to width ration of males, females, right, left, right side side of the males, left side of the males, right side of the females and left side of the females were 0.32 ± 0.03, 0.32 ± 0.04, 0.32 ± 0.04, 0.31 ± 0.03, 0.32 ± 0.04, 0.31 ± 0.03 , 0.32 ± 0.04 and 0.31 ± 0.04 respectively. **(Table 21) (Graph 17)**. The mean values of the females, right side, right side of the males and right side of the females were more than that of males, left side, left side of the females and left side of the females respectively.

8)**EXTRUSION INDEX :**

0.13 ± 0.02 , 0.12 ± 0.22 , 0.12 ± 0.02 , 0.12 ± 0.02 , 0.13 ± 0.02, 0.12 ± 0.19, 0.12 ± 0.01 and 0.12 ± 0.03 are the average measurements of extrusion index in males, females, right, left, right sided acetabulum of males , left sided acetabulum of males, right sided acetabulum of females and left sided acetabulum of females respectively**.(Table 22) (Graph 18).** The average value of extrusion index was more

in males, right side of the males and left side of the females than the females, left side of the males and right side of the females respectively. Right and left side equalled their measurements.

9)LATERAL SUBLUXATION:

The mean values of the LS obtained were 7.59 ± 1.40 mm, 7.34 ± 1.36 mm, 7.85 ± 1.49 mm, 7.85 ± 1.40 mm, 8.43 ± 1.43 mm, 8.26 ± 1.27 mm, 7.25 ± 1.31 mm, 7.43 ± 1.41mm in males, females, right side, left side, right side acetabulum of the males, left side acetabulum of the males, right side acetabulum of the females and left side of the females respectively**.(Table 23) (Graph 19).** Males, right side, right side of the males and left side of the females had more average LS than females, left side, left side of the males and right side of the females respectively.

10)PEAK EDGE DISTANCE:

On observation the average measurement of peak to edge distance in males , females , right side ,left side , right side acetabulum of the males, left side acetabulum of the males, right side acetabulum of the females and left side of the females were 19.26 ± 2.49 mm, 17.64 ± 2.65 mm, 18.7 ± 2.70 mm, 18.24 ± 2.67 mm, 19.66 ± 2.40 mm, 18.87 ± 2.53 mm, 17.70 ± 2.64 mm and 17.59 ± 2.68 mm respectively**. (Table 24) (Graph 20)**. Males, right side, right side of the males and right side of the females have more average values of PED than females, left side, left side of the females and left side of the females respectively.

11) JOINT SPACE WIDTH :

8.3 ± 1.35 mm, 7.66 ± 1.02 mm, 8.02 ± 1.28 mm, 7.95 ± 1.20 mm, 8.46 ± 1.38 mm, 8.14 ± 1.33 mm, 7.56 ± 1.00 mm, 7.76 ± 1.05 mm are the results on measuring the joint space width in males, females, right, left, right side acetabulum in males and left side acetabulum in females respectively**.(Table 25) (Graph 21)**. Males, right, right side of the males , left side of the females have more average than females, left, left side of the males and right side of the acetabulum.

TOTAL (n=210) : Out of 210 pelvis Xrays examined including both males and females, and considering both the sides (right , left) , the average values of CEangle, acetabular depth, acetabular angle, acetabular roof obliquity, acetabular index angle, roof angle, depth to width ratio, extrusion index, lateral subluxation, peak to edge distance and joint space width were 42.40 ± 2.83˚, 20.88 ± 2.42 mm, 36.25 ± 3.10˚, 9.67 ± 1.90˚, 18.74 ± 2.09˚, 0.32 ± 0.04, 0.12 ± 0.03, 7.85 ± 1.44 mm, 18.47 ± 2.69 mm and 7.98 ± 1.24 mm respectively**.(Table 26) (Graph 22).**

COMPARISON OF MEASUREMENTS WITHIN THE AGE GROUPS :

1) 18 to 29 years

2) 30 to 39 years

3) 40 to 49 years

4) 50 to 59 years

5) More than 60 years**(Table 27 a , 27 b).**

CENTRE EDGE (CE) angle (TABLE 15)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	36.80	53.20	42.89	3.02
TOTAL FEMALES (n = 104)	35.00	48.90	41.91	2.52
TOTAL RIGHT (n = 105)	37.40	52.90	42.33	2.68
TOTAL LEFT (n = 105)	35.00	53.20	42.48	2.97
RIGHT MALES (n = 53)	37.70	52.90	42.79	3.00
LEFT MALES (n = 53)	36.80	53.20	43.00	3.08
RIGHT FEMALES (n = 52)	37.40	48.80	41.86	2.25
LEFTFEMALES (n = 52)	35.00	48.90	41.95	2.79

ACETABULAR DEPTH (TABLE 16)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 106)	16.53	28.61	21.92	2.61
TOTAL FEMALES (n = 106)	16.38	26.47	19.84	1.67
TOTAL RIGHT (n = 104)	16.97	28.61	21.07	2.42
TOTAL LEFT(n = 104)	16.38	26.48	20.71	2.43
RIGHT MALES (n = 53)	17.61	28.61	21.99	2.56
LEFT MALES(n = 53)	16.53	26.48	21.84	2.68
RIGHT FEMALES (n = 52)	16.97	26.47	20.21	1.87
LEFT FEMALES (n = 52)	16.38	22.19	19.55	1.42

ACETABULAR ANGLE (TABLE 17)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	26.80	42.00	36.06	2.66
TOTAL FEMALES (n = 104)	28.60	42.00	36.25	3.24
TOTAL RIGHT (n = 105)	29.80	42.00	36.37	3.08
TOTAL LEFT (n = 105)	26.80	41.90	36.13	3.12
RIGHT MALES (n = 53)	30.30	42.00	36.08	2.95
LEFT MALES (n = 53)	26.80	41.00	36.04	3.00
RIGHT FEMALES (n = 52)	29.80	42.00	36.68	3.26
LEFT FEMALES (n = 52)	28.60	41.90	36.22	3.26

ACETABULAR ROOF OBLIQUITY (TABLE 18)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	6.20	16.80	9.69	2.07
TOTAL FEMALES (n = 104)	4.50	14.50	9.64	1.72
TOTAL RIGHT (n = 105)	6.30	15.80	9.82	1.83
TOTAL LEFT (n = 105)	4.50	16.80	9.51	1.96
RIGHT MALES(n = 53)	6.80	15.80	9.87	2.06
LEFT MALES(n = 53)	6.20	16.80	9.52	2.13
RIGHT FEMALES (n = 52)	6.30	14.50	9.77	1.66
LEFT FEMALES (n = 52)	4.50	14.00	9.50	1.79

ACETABULAR INDEX ANGLE (TABLE 19)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	16.90	41.00	24.91	4.09
TOTAL FEMALES (n =104)	18.40	32.60	25.08	3.18
RIGHT (n = 105)	17.20	41.00	24.95	3.88
LEFT (n = 105)	16.90	36.80	25.04	3.45
RIGHT MALES(n = 53)	17.20	41.00	24.90	4.34
LEFT MALES(n = 52)	16.90	36.80	24.92	3.87
RIGHT FEMALES(n = 53)	19.40	32.10	25.00	3.39
LEFT FEMALES (n=52)	18.40	32.60	25.15	2.99

ROOF ANGLE (TABLE 20)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	16.00	25.20	19.55	2.00
TOTAL FEMALES (n =104)	14.80	23.20	17.91	1.84
TOTAL RIGHT (n = 105)	14.80	25.20	18.90	2.02
TOTAL LEFT (n = 105)	15.10	24.00	18.58	2.15
RIGHT MALES(n = 53)	18.00	25.20	19.90	1.79
LEFT MALES(n = 52)	16.00	24.00	19.20	2.14
RIGHT FEMALES(n = 53)	14.80	23.20	17.88	1.73
LEFT FEMALES (n=52)	15.10	23.20	17.93	1.97

DEPTH TO WIDTH RATIO (TABLE 21)

GROUPS	MINIMUM	MAXIMUM	MEAN	S.D
TOTAL MALES(n = 106)	0.23	0.43	0.32	0.03
TOTAL FEMALES (n = 104)	0.22	0.49	0.32	0.04
TOTAL RIGHT (n = 105)	0.24	0.49	0.32	0.04
TOTAL LEFT (n = 105)	0.22	0.48	0.31	0.03
RIGHT MALES (n = 53)	0.26	0.43	0.32	0.04
LEFT MALES (n = 53)	0.23	0.41	0.31	0.03
RIGHT FEMALES(n = 52)	0.24	0.49	0.32	0.04
LEFT FEMALES (n = 52)	0.22	0.48	0.31	0.04

EXTRUSION INDEX (TABLE 22)

GROUPS	MINIMUM	MAXIMUM	MEAN	S.D
TOTAL MALES (n = 106)	0.08	0.19	0.13	0.02
TOTAL FEMALES (n = 104)	0.09	0.28	0.12	0.22
TOTAL RIGHT (n = 105)	0.08	0.16	0.12	0.02
TOTAL LEFT (n = 105)	0.09	0.28	0.12	0.02
RIGHT MALES(n = 53)	0.08	0.16	0.13	0.02
LEFT MALES(n = 52)	0.09	0.19	0.12	0.19
RIGHT FEMALES(n = 53)	0.09	0.16	0.12	0.19
LEFT FEMALES (n=52)	0.09	0.26	0.12	0.03

LATERAL SUBLUXATION (TABLE 23)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 106)	8.44	24.66	19.26	2.49
TOTAL FEMALES (n = 104)	10.91	23.31	17.64	2.65
TOTAL RIGHT (n = 105)	11.81	24.66	18.7	2.7
TOTAL LEFT (n = 105)	8.44	23.92	18.24	2.67
RIGHT MALES (n = 53)	13.00	24.66	19.66	2.40
LEFT MALES (n = 53)	8.44	23.92	18.87	2.53
RIGHT FEMALES (n = 52)	11.81	23.31	17.7	2.64
LEFT FEMALES (n = 52)	10.91	22.03	17.59	2.68

PEAK EDGE DISTANCE (TABLE 24)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 106)	4.69	11.91	7.85	1.44
TOTAL FEMALES (n = 104)	4.69	10.51	7.34	1.36
TOTAL RIGHT (n = 105)	4.89	10.86	7.85	1.49
TOTAL LEFT (n = 105)	4.69	11.91	7.85	1.40
RIGHT MALES (n = 53)	6.00	10.86	8.43	1.43
LEFT MALES(n = 53)	5.91	11.91	8.26	1.27
RIGHT FEMALES(n = 52)	4.89	10.51	7.25	1.31
LEFT FEMALES(n = 52)	4.69	10.36	7.43	1.41

JOINT SPACE WIDTH (TABLE 25)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 106)	4.88	11.00	8.30	1.35
TOTAL FEMALES (n = 104)	5.46	9.83	7.66	1.02
TOTAL RIGHT (n = 105)	4.88	11.00	8.02	1.28
TOTAL LEFT (n = 105)	5.48	10.70	7.95	1.20
RIGHT MALES (n = 53)	4.88	11.00	8.46	1.38
LEFT MALES (n = 53)	5.48	10.70	8.14	1.33
RIGHT FEMALES (n = 52)	5.46	9.64	7.56	1.00
LEFT FEMALES (n = 52)	6.07	9.83	7.76	1.05

TOTAL (n = 210) (TABLE 26)

S.NO	PARAMETERS	MINIMUM	MAXIMUM	MEAN	S.D.
1.	**CE angle(^{0})**	35.00	53.20	42.40	2.83
2.	**AD(mm)**	16.38	28.61	20.88	2.42
3.	**AA(^{0})**	26.80	42.00	36.25	3.10
4.	**ARO(^{0})**	4.50	16.80	9.67	1.90
5.	**AIA(^{0})**	16.90	41.00	24.99	3.66
6.	**RA(^{0})**	14.80	25.20	18.74	2.09
7.	**DTW**	0.22	0.49	0.32	0.04
8.	**EI**	0.08	0.28	0.12	0.03
9.	**LS(mm)**	4.69	11.91	7.85	1.44
10.	**PED(mm)**	8.44	24.66	18.47	2.69
11.	**JSW(mm)**	4.88	11.00	7.98	1.24

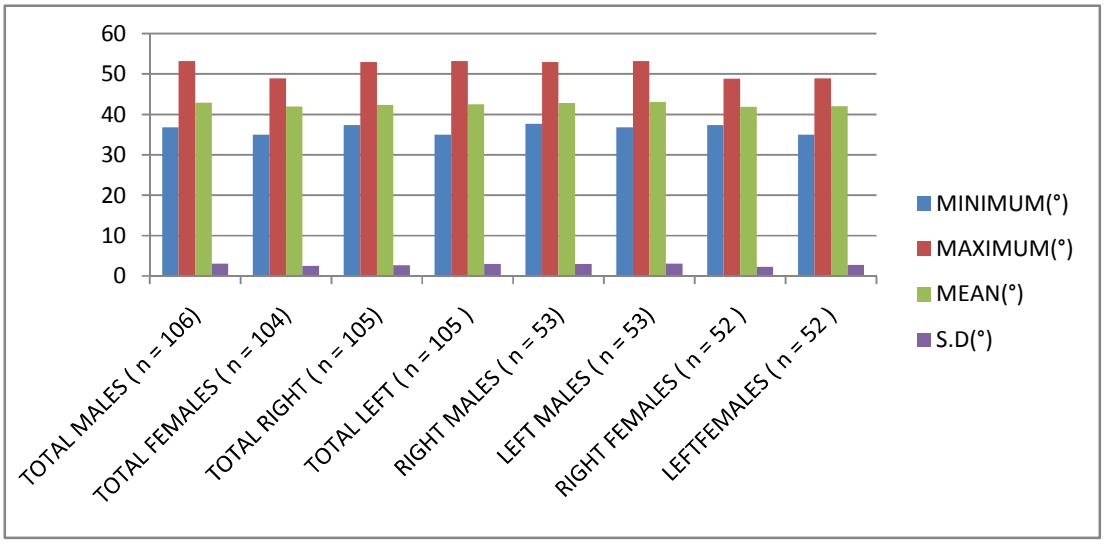
S.NO	AGE GROUPS (years)	CEA		AD (mm)		AA		ARO		AIA	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1.	**18 to 29**	42.47	3.04	22.17	2.81	34.94	3.24	8.60	1.54	24.16	2.86
2.	**30 to 39**	42.60	2.55	20.60	2.20	35.87	3.27	10.31	1.75	24.31	4.09
3.	**40 to 49**	41.53	2.77	20.05	2.01	36.71	3.07	9.62	1.78	25.40	3.71
4.	**50 to 59**	42.62	2.38	21.44	2.61	36.59	2.78	9.79	2.28	25.09	3.43
5.	**> 60**	44.24	3.42	21.70	2.42	36.21	3.13	9.21	1.56	25.85	3.63

Table 27 a: Acetabular parameters in X RAYS , observed under different age groups of both the sexes

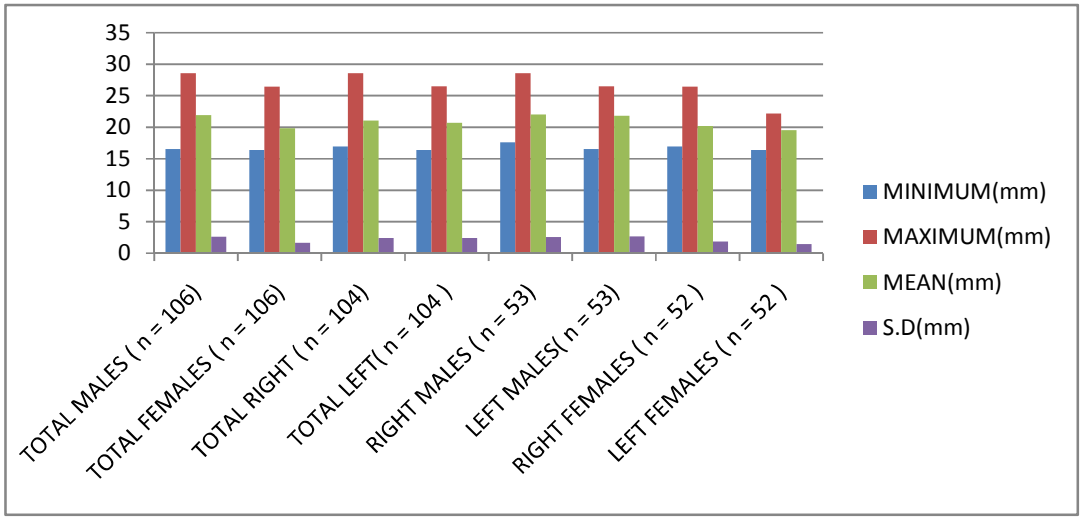
S.NO	AGE GROUPS (years)	RA		DTW		EI		LS (mm)		PED (mm)		JSW (mm)	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1.	**18 to 29**	18.31	1.96	0.31	0.03	0.12	0.02	7.27	1.17	19.79	1.91	6.77	0.83
2.	**30 to 39**	18.91	2.22	0.32	0.03	0.13	0.03	7.37	1.49	18.37	2.27	7.81	1.28
3.	**40 to 49**	18.31	1.98	0.32	0.03	0.12	0.02	7.64	1.16	18.07	3.05	7.85	0.89
4.	**50 to 59**	18.72	1.85	0.32	0.04	0.12	0.02	8.56	1.61	18.47	2.98	8.46	1.42
5.	**> 60**	20.21	2.24	0.33	0.06	0.13	0.02	8.56	1.21	18.61	1.99	9.00	0.77

Table 27 b : Acetabular parameters in X RAYS , observed under different age groups of both the sexes

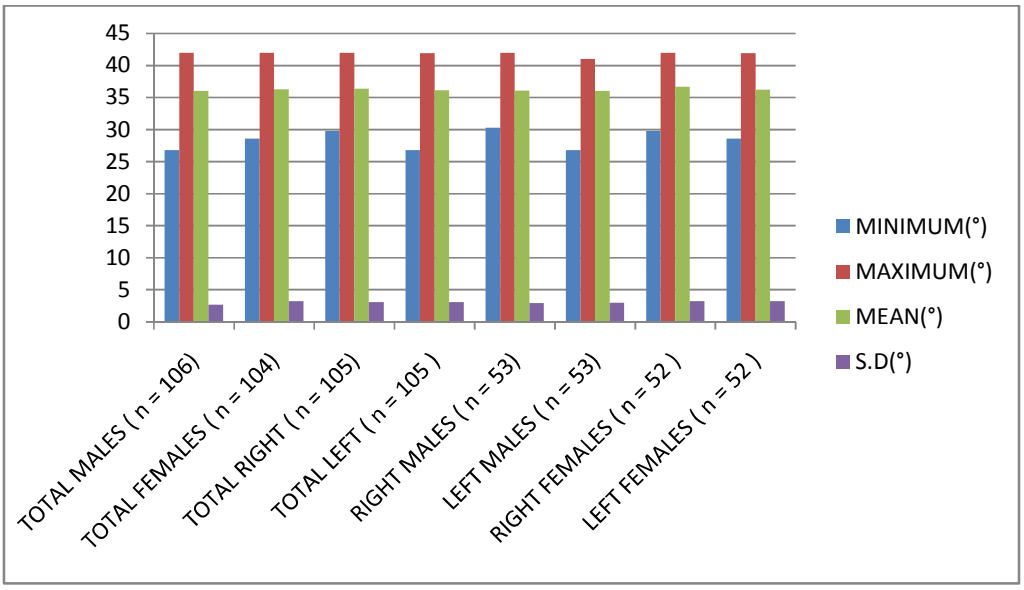
(GRAPHS FOR ACETABULARPARAMETERS IN X RAYS)



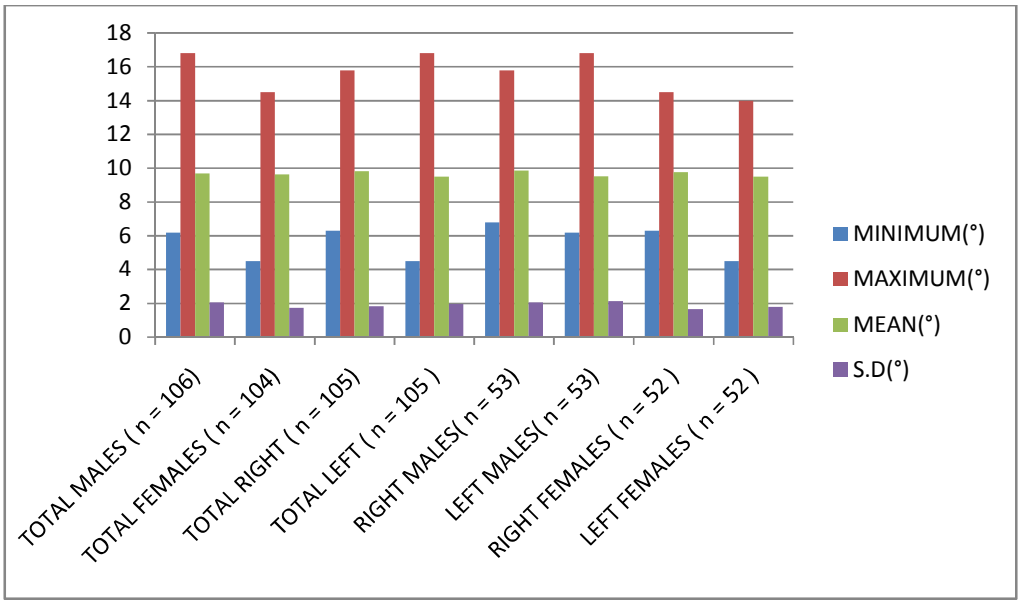
(Graph 11 : Depicting the min, max, mean, S.D. values of CE angle in various groups).



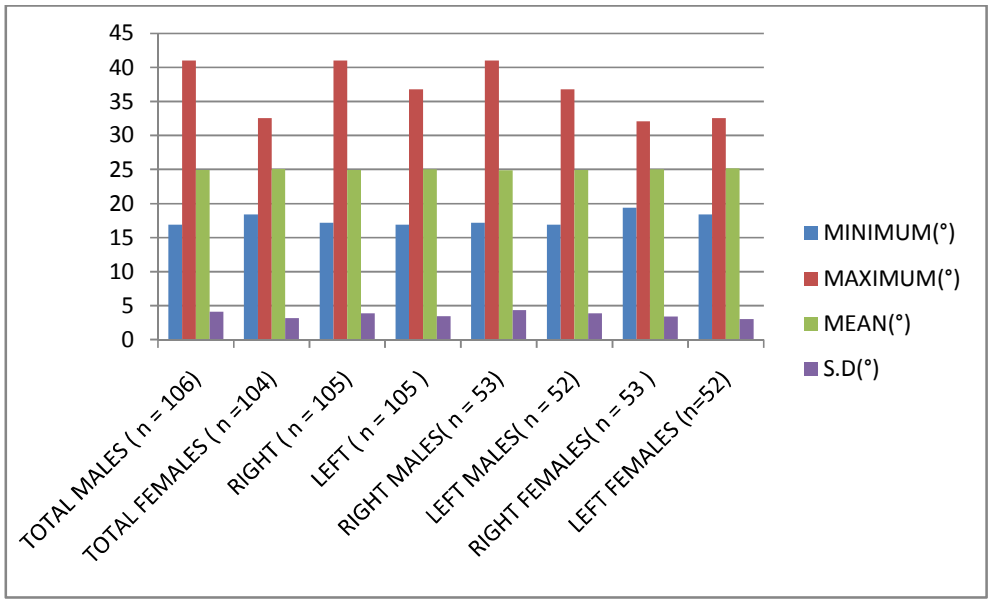
(Graph 12: The min, max, mean and S.D. values of acetabular depth in various groups)



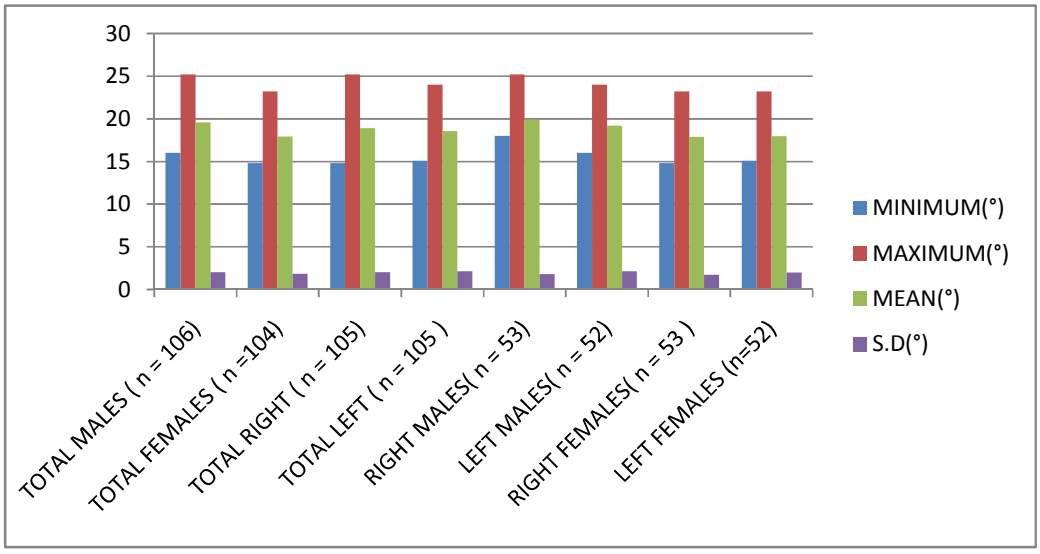
(Graph 13 : The min , max, mean and S.D values of acetabular angle in various groups).



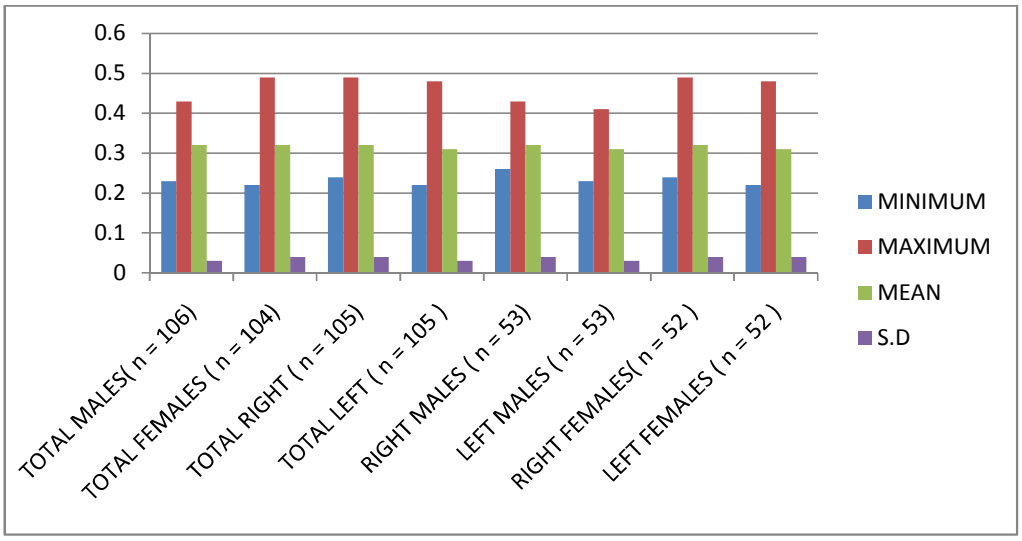
(Graph 14 : The min, max, mean and S.D. values of acetabular roof obliquity in various groups).



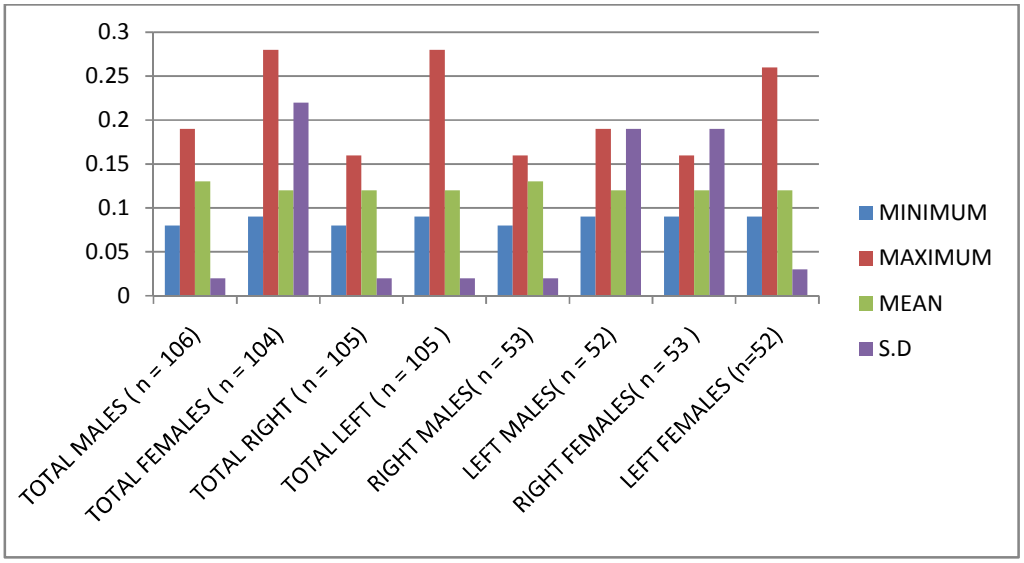
(Graph 15 : The min, max, mean and S.D. values of acetabular index angle in various groups).



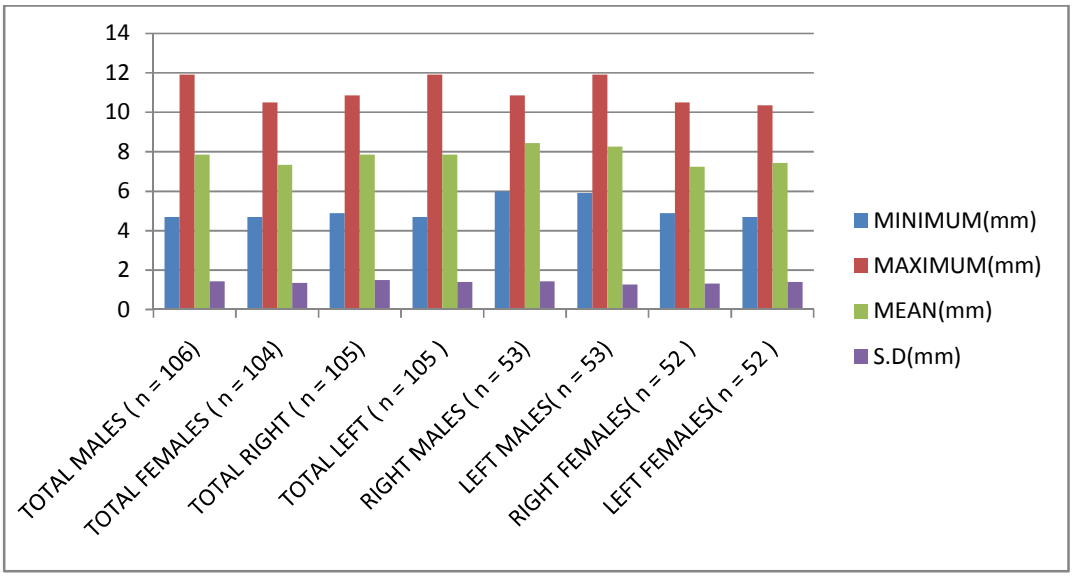
(Graph 16 : The min, max, mean and S.D values of roof angle in various groups.)



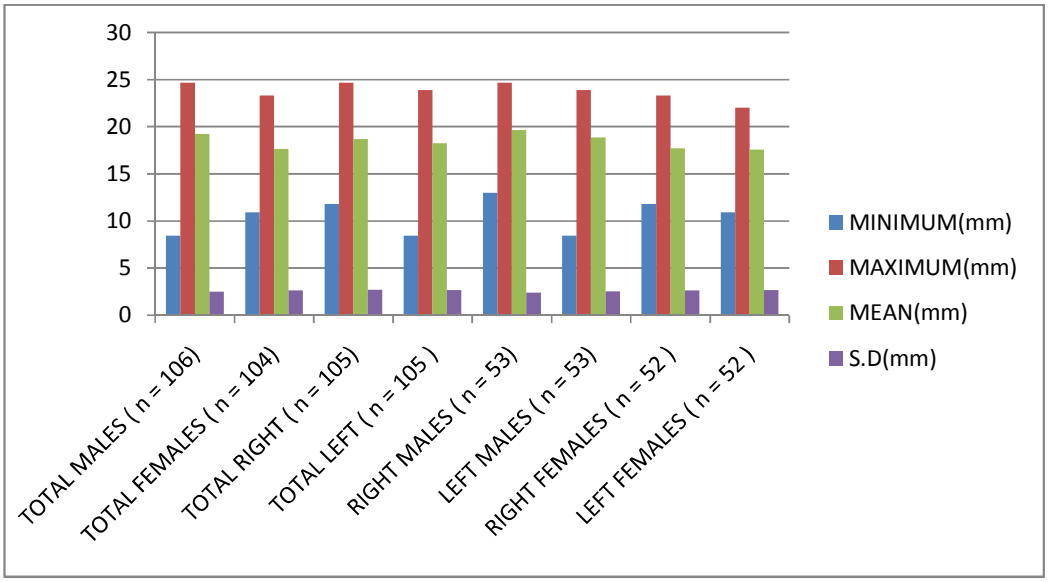
(Graph 17 : The measurements of various groups regarding depth to width ratio)



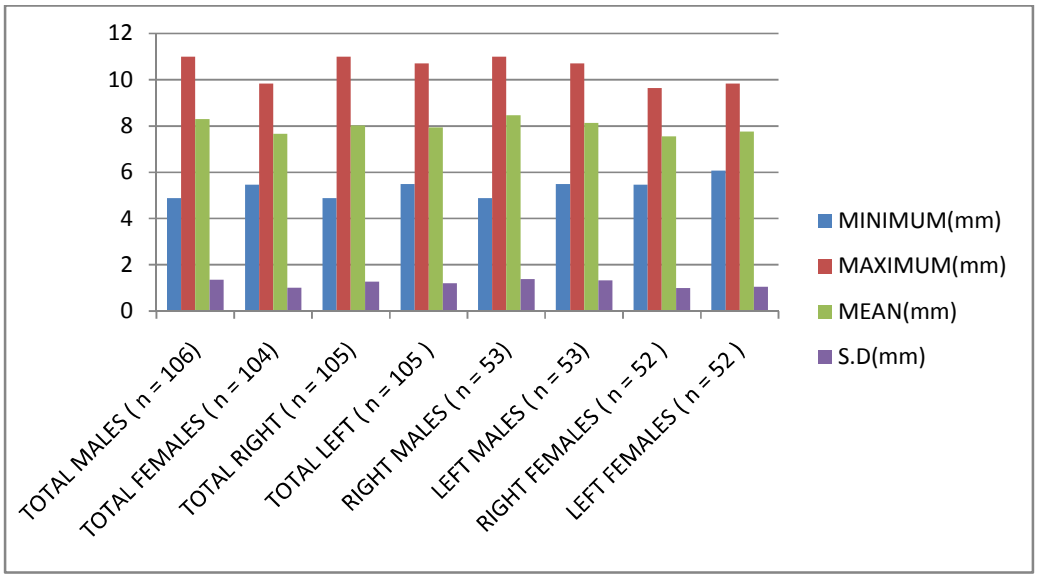
(Graph 18: The values of extrusion index in various groups.)



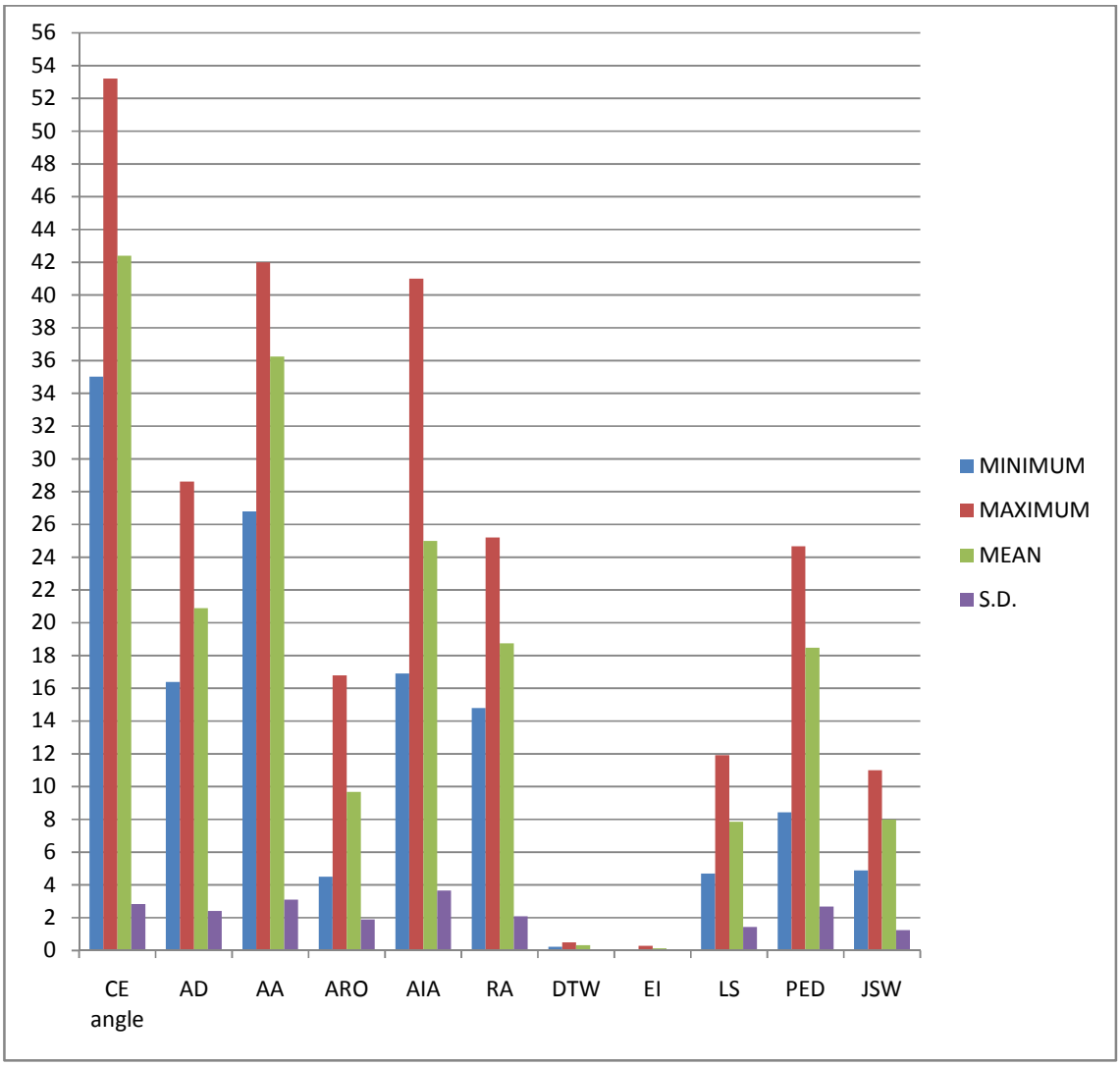
(Graph 19 : The measurements of lateral Subluxation in various groups).



(Graph 20 : The min, max, mean and S.D of peak to edge distance in various groups)

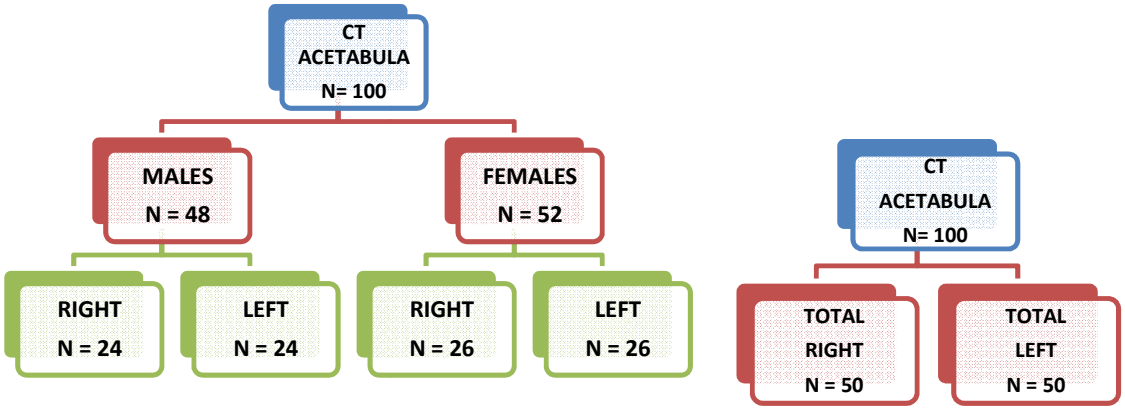


(Graph 21 : The measurements of Joint space width in various groups).



(Graph 22 : The total parametric values of all the 210 xrays)

D) CT ABDOMEN & PELVIS ASSESSMENT: (TOTAL : 100 ACETABULA)



SEX DETERMINATION:	**SIDE DETERMINATION:**
Total number of male pelvis: 24. (48 acetabula)	Total number of right sided acetabulum : 50.
Total number of female pelvis: 26. (52 acetabula)	Total number of left sided acetabulum : 50.

SEX AND SIDE DETERMINATION:

Total number of right sided male acetabulum : 24.	Total number of right sided female acetabulum : 26.
Total number of left sided male acetabulum : 24.	Total number of left sided male acetabulum : 26.

ACETABULAR PARAMETERS

1)CE angle	2)AD	3)AA	4)ARO
5)AIA	6)RA	7)DTW	8)EI
9)LS	10)PED	11)AV	12)JSW
13)AASA	14)PASA		

1)CENTRE EDGE (CE) angle :

The mean acetabular CE angle values measured in CT Abdomen and pelvis were 43.70 ± 4.54, 42.52 ± 4.08, 43.31 ± 4.36, 42.87 ± 4.33, 43.97 ± 4.41, 43.42 ± 4.76, 42.70 ± 4.30 and 42.35 in males, females, right side, left side, right side of the males, left side of the males, right side of the females and left side of the females respectively**.(Table 28) (Graph 23).** Males, right side, right side of the males and left side of the females outnumbered in average , with their counterparts.

2)ACETABULAR DEPTH :

The average measurements of acetabular depth in males, females, right side, left side, right side of the males, left side of the males, right side of the males, right side of the females, left side of the females were 20.27 ± 2.35°, 18.20 ± 2.77°, 19.34 ± 2.89°, 19.04 ± 2.67°, 20.34 ± 2.34°, 20.2 ± 2.41°, 18.43 ± 3.08° and 17.98 ± 2.47° respectively**.(Table 29) (Graph 24).** The mean values of males, right, right side of the males and right side of the females were more than that of females, left, left side of the males and left side of the females respectively.

3)ACETABULAR ANGLE :

The results based on the observations made on the various groups such as males, females, right side, left side, right side acetabulum of males, left side acetabulum of males, right side acetabulum of females and left side acetabulum of the females for mean acetabular angle were 37.86 ± 2.94°, 39.37 ± 2.41°, 38.8 ± 2.83°, 38.49 ± 2.72°, 38.14 ± 3.09°, 37.59 ± 2.83°, 39.42 ± 2.47° and 39.31 ± 2.34° respectively**.(Table 30) (Graph 25).** In females, right side, right side of the males,

right side of the females the values of average acetabular angle were more than that of the males, left side, left side of the males and left side of the females respectively.

4)ACETABULAR ROOF OBLIQUITY :

12.00± 3.24˚ , 12.57 ± 3.19˚ , 12.27 ± 3.25˚ , 12.32 ± 3.20˚ , 11.90 ± 3.05˚ , 12.10 ± 3.48˚ , 12.62 ± 3.44˚ and 12.53 ± 2.99˚ were the results of males , females , right side, left side, right side acetabulum of the males, left side acetabulum of the males, right side of the females and left side of the females respectively while measuring the acetabular roof obliquity**.(Table 31) (Graph 26).** Males, left side, left side of the males, right side of the females average value outnumbered females, left side, left side of the females and left side of the females respectively.

5)ACETABULAR INDEX ANGLE:

The mean acetabular index angle of various groups such as males, females, right side, left side, right side of the males, left side of the males , right side of the females and the left side of the females were 25.56 ± 4.72˚ , 26.61 ± 5.09˚ , 26.56 ± 5.04˚ , 25.69 ± 4.80˚ , 25.82 ± 4.89˚ , 25.30 ± 4.63˚ , 27.25 ± 5.18˚ and 25.98 ± 5.04˚ respectively**.(Table 32) (Graph 27).** The average values of females, right side, right side of the males, right side of the females were more than that of the males, left side of the males and right side of the females respectively.

6)ROOF ANGLE:

The mean values of the acetabular roof angle were 20.57 ± 2.70˚, 17.65 ± 2.17˚,18.96 ± 2.91˚ , 19.14 ± 2.79˚, 20.53 ± 2.92˚, 20.60 ± 2.17˚ ,17.52 ± 2.04˚ and 17.79 ± 2.31˚ in males, females, right side, left side, right side of the males, left side of the males, right side of the females and left side of the females respectively**.(Table 33) (Graph 28).** The mean values of males, left side, left side of the males, left side of the females were more than that of the females, right side, right side of the males and right side of the females respectively.

7)DEPTH TO WIDTH RATIO :

The mean values of the depth to width ration of males, females, right, left, right side side of the males, left side of the males, right side of the females and left side of the females were 0.32 ± 0.04, 0.31± 0.05 , 0.32 ± 0.04 , 0.31 ± 0.04, 0.33 ± 0.03, 0.32 ± 0.04 , 0.32 ± 0.05 and 0.31 ± 0.04 respectively. **(Table 34) (Graph 29)**. The mean values of the males, right side, right side of the males and right side of the females were more than that of females, left side, left side of the females and left side of the females respectively.

8)EXTRUSION INDEX :

The mean values of the extrusion index in males, females, right, left, right side of the males, left side of the males, right side of the females and left side of the females were 0.13 ± 0.03 , 0.14 ± 0.03 , 0.13 ± 0.31 , 0.13 ± 0.35 , 0.12 ± 0.03, 0.13 ± 0.04 , 0.13 ± 0.03 , 0.14 ± 0.34 respectively.**(Table 35) (Graph30)**. The average value of extrusion index was more in females, left side, left side of the males and left side of

the females than the males, right side, right side of the males and right side of the females respectively. Right and left side equalled their measurements.

9)LATERAL SUBLUXATION :

The mean values of the LS obtained were 5.94 ± 1.20 mm , 5.44 ± 1.30 mm, 5.80 ± 1.34 mm, 5.56 ± 1.19 mm , 6.09 ± 1.24 mm , 5.78 ± 1.16 mm , 5.52 ± 1.40 mm , 5.35 ± 1.20 mm in males, females, right side, left side, right side acetabulum of the males, left side acetabulum of the males, right side acetabulum of the females and left side of the females respectively**.(Table 36) (Graph 31).** Males, right side, right side of the males and right side of the females had more average LS than females, left side, left side of the males and left side of the females respectively.

10) PEAK TO EDGE DISTANCE :

On observation the average measurement of peak to edge distance in males, females, right side, left side, right side acetabulum of the males, left side acetabulum of the males, right side acetabulum of the females and left side of the females were 19.69 ± 2.61 mm, 18.24 ± 2.26 mm, 19.17 ± 2.74 mm, 18.70 ± 2.30 mm, 19.94 ± 2.89 mm, 19.45 ± 2.32 mm, 18.47 ± 2.44 mm, 18 ± 2.08 mm respectively**.(Table 37) (Graph 32)**. Males, right side, right side of the males and right side of the females have more average values of PED than females, left side, left side of the females and left side of the females respectively.

11) ACETABULAR VERSION:

On observation the average measurement of acetabular version in males, females, right side,left side, right side acetabulum of the males, left side acetabulum of the males, right side acetabulum of the females and left side of the females were 20.19 ± 4.56˚, 21.68 ± 4.48˚, 20.46 ± 4.63˚, 21.47 ± 4.47˚, 19.73 ± 4.61˚, 20.66 ± 4.56˚, 21.14 ± 4.64˚ and 22.22 ± 4.34˚ respectively**.(Table 38) (Graph 33).** Females, left side, left side of the males and left side of the females have more average values of AV than males, right side, right side of the males and right side of the females respectively.

12)JOINT SPACE WIDTH :

8.30 ± 1.35˚, 7.66 ± 1.02˚, 8.02 ± 1.28˚, 7.95 ± 1.20˚, 8.46 ± 1.38˚, 8.14 ± 1.33˚, 7.56 ± 1.00˚, 7.76 ± 1.05˚ are the results on measuring the joint space width in males, females, right, left, right side acetabulum in males and left side acetabulum in females respectively**.(Table 39) (Graph 34).** Males, right, right side of the males, left side of the females have more average than females, left, left side of the males and right side of the acetabulum.

13)**ANTERIOR ACETABULAR SECTOR ANGLE :**

The mean anterior acetabular sector angle of various groups such as males, females, right side, left side, right side of the males, left side of the males, right side of the females and the left side of the females were 69.20˚ ± 6.02, 68.86 ± 8.46˚, 69.08 ± 8.59˚, 68.97 ± 5.96˚, 68.59 ± 6.00˚, 69.8 ± 6.10˚, 69.53 ± 10.53˚ and 68.19 ± 5.83˚ respectively**.(Table 40) (Graph 35).** Males, right, left side of the males, right side of

the females have more average than females, left, right side of the males and left side of the acetabulum.

14)POSTERIOR ACETABULAR SECTOR ANGLE :

The mean posterior acetabular sector angle of various groups such as males, females, right side, left side, right side of the males, left side of the males, right side of the females and the left side of the females were 106.08 ± 12.87˚, 108.35 ± 8.53˚, 105.72 ± 12.11˚, 108.80 ± 9.29˚, 104.42 ± 14.36˚, 107.75 ± 11.23˚, 106.93 ± 9.73˚ and 109.76 ± 7.15˚ respectively**.(Table 41) (Graph 36).** Females, left, left side of the males, left side of the females have more average than males, right, right side of the males and right side of the females.

TOTAL (BOTH MALES & FEMALES, RIGHT & LEFT):

Out of 100 CT abdomen and pelvis examined including both males and females, and considering both the sides (right, left), the average values of CEangle, AD, AA, ARO, AIA, RA, DTW, EI, LS, PED, AV, JSW, AASA and PASA are 43.09 ± 4.33˚, 19.19 ± 2.77 mm, 38.65 ± 2.77˚ , 12.30 ± 3.21˚, 26.11 ± 4.92˚ , 19.05 ± 2.83˚, 0.32 ± 0.04, 0.13 ± 0.03 , 5.68 ± 1.27 mm , 18.94 ± 2.53 mm , 20.97 ± 4.55˚, 6.98 ± 1.09 mm, 69.02 ± 7.05 ˚and 107.26 ± 10.85˚ respectively**.(Table 42) (Graph 37)**. Males, left side, left side of the males and left side of the females outnumbered in average, with their counterpart.

COMPARISON OF MEASUREMENTS WITHIN THE AGE GROUPS :

The results were documented **(Table 43 a, 43 b)**under the groups 18 to 29 years, 30 to 39 years, 40 to 49 years, 50 to 59 years and More than 60 years.

CENTRE EDGE (CE) angle (TABLE 28):

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTALMALES (n = 48)	33.00	51.80	43.70	4.54
TOTAL FEMALES (n = 52)	33.40	54.40	42.52	4.08
TOTAL RIGHT (n = 50)	35.20	54.40	43.31	4.36
TOTAL LEFT (n = 50)	33.00	51.00	42.87	4.33
RIGHT MALES (n = 24)	33.40	54.40	43.97	4.41
LEFT MALES (n = 24)	33.00	51.00	43.42	4.76
RIGHT FEMALES (n = 26)	35.20	54.40	42.70	4.30
LEFT FEMALES (n = 26)	33.40	49.40	42.35	3.92

ACETABULAR DEPTH (TABLE 29)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 106)	15.17	25.28	20.27	2.35
TOTAL FEMALES (n = 104)	11.18	24.71	18.2	2.77
TOTAL RIGHT (n = 105)	11.18	25.28	19.34	2.89
TOTAL LEFT (n = 105)	13.15	24.45	19.04	2.67
RIGHT MALES (n = 53)	11.18	24.71	20.34	2.34
LEFT MALES (n = 53)	15.17	24.45	20.20	2.41
RIGHT FEMALES (n = 52)	11.18	24.71	18.43	3.08
LEFT FEMALES (n = 52)	13.15	21.91	17.98	2.47

ACETABULAR ANGLE (TABLE 30)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	31.60	42.70	37.86	2.94
TOTAL FEMALES (n = 104)	33.70	44.80	39.37	2.41
TOTAL RIGHT (n = 105)	32.30	44.80	38.80	2.83
TOTAL LEFT (n = 105)	31.60	44.70	38.49	2.72
RIGHT MALES (n = 53)	33.70	44.80	38.14	3.09
LEFT MALES (n = 53)	31.60	42.30	37.59	2.83
RIGHT FEMALES (n = 52)	33.70	44.80	39.42	2.47
LEFT FEMALES (n = 52)	35.60	44.70	39.31	2.34

ACETABULAR ROOF OBLIQUITY (TABLE 31)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	6.70	21.80	12.00	3.24
TOTAL FEMALES (n = 104)	5.20	20.60	12.57	3.19
TOTAL RIGHT (n = 105)	5.20	21.80	12.27	3.25
TOTALLEFT (n = 105)	7.50	20.60	12.32	3.20
RIGHT MALES (n = 53)	5.20	20.60	11.90	3.05
LEFT MALES (n = 53)	7.50	20.40	12.10	3.48
RIGHT FEMALES (n = 52)	5.20	20.10	12.62	3.44
LEFT FEMALES (n = 52)	7.60	20.60	12.53	2.99

ACETABULAR INDEX ANGLE (TABLE 32)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	14.20	34.20	25.56	4.72
TOTALFEMALES (n = 104)	13.90	39.30	26.61	5.09
TOTAL RIGHT (n = 105)	14.20	39.10	26.56	5.04
TOTAL LEFT (n = 105)	13.90	39.30	25.69	4.80
RIGHT MALES (n = 53)	13.90	39.30	25.82	4.89
LEFT MALES (n = 53)	16.50	31.10	25.3	4.63
RIGHT FEMALES (n = 52)	18.00	39.10	27.25	5.18
LEFT FEMALES (n = 52)	13.90	39.30	25.98	5.04

ROOF ANGLE (TABLE 33)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	14.90	28.10	20.57	2.7
TOTAL FEMALES (n = 104)	14.30	23.20	17.65	2.17
TOTAL RIGHT (n = 105)	14.80	28.10	18.96	2.91
TOTAL LEFT (n = 105)	14.30	27.30	19.14	2.79
RIGHT MALES (n = 53)	14.30	23.20	20.53	2.92
LEFT MALES (n = 53)	16.20	27.30	20.60	2.17
RIGHT FEMALES (n = 52)	14.80	22.20	17.52	2.04
LEFT FEMALES (n = 52)	14.30	23.20	17.79	2.31

DEPTH TO WIDTH RATIO (TABLE 34)

GROUPS	MINIMUM	MAXIMUM	MEAN	S.D
TOTAL MALES (n = 106)	0.24	0.39	0.32	0.04
TOTAL FEMALES (n = 104)	0.21	0.43	0.31	0.05
TOTAL RIGHT (n = 105)	0.21	0.43	0.32	0.04
TOTAL LEFT (n = 105)	0.23	0.37	0.31	0.04
RIGHT MALES (n = 53)	0.21	0.43	0.33	0.03
LEFT MALES (n = 53)	0.24	0.37	0.32	0.04
RIGHT FEMALES (n = 52)	0.21	0.43	0.32	0.05
LEFT FEMALES (n = 52)	0.23	0.37	0.31	0.04

EXTRUSION INDEX (TABLE: 35)

GROUPS	MINIMUM	MAXIMUM	MEAN	S.D
TOTAL MALES (n = 106)	0.07	0.26	0.13	0.03
TOTAL FEMALES (n = 104)	0.07	0.19	0.14	0.03
TOTAL RIGHT (n = 105)	0.08	0.23	0.13	0.31
TOTAL LEFT (n = 105)	0.07	0.26	0.13	0.35
RIGHT MALES (n = 53)	0.07	0.19	0.12	0.03
LEFT MALES (n = 53)	0.09	0.26	0.13	0.04
RIGHT FEMALES (n = 52)	0.08	0.19	0.13	0.03
LEFT FEMALES (n = 52)	0.07	0.19	0.14	0.34

LATERAL SUBLUXATION (TABLE 36)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 106)	3.80	8.52	5.94	1.20
TOTAL FEMALES (n = 104)	2.71	9.13	5.44	1.30
TOTAL RIGHT (n = 105)	3.93	9.13	5.80	1.34
TOTAL LEFT (n = 105)	2.71	8.88	5.56	1.19
RIGHT MALES (n = 53)	2.71	9.13	6.09	1.24
LEFT MALES (n = 53)	3.80	8.19	5.78	1.16
RIGHT FEMALES (n = 52)	3.93	9.13	5.52	1.40
LEFT FEMALES (n = 52)	2.71	8.88	5.35	1.20

PEAK TO EDGE DISTANCE (TABLE 37)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 106)	12.80	24.97	19.69	2.61
TOTAL FEMALES (n = 104)	13.46	22.62	18.24	2.26
TOTAL RIGHT (n = 105)	13.46	24.97	19.17	2.74
TOTAL LEFT (n = 105)	12.80	24.07	18.70	2.30
RIGHT MALES (n = 53)	13.46	22.62	19.94	2.89
LEFT MALES (n = 53)	12.80	24.07	19.45	2.32
RIGHT FEMALES (n = 52)	13.46	22.05	18.47	2.44
LEFT FEMALES (n = 52)	14.58	22.62	18.00	2.08

ACETABULAR VERSION (TABLE 38)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	9.70	37.00	20.19	4.56
TOTAL FEMALES (n = 104)	11.60	29.50	21.68	4.48
TOTAL RIGHT (n = 105)	9.70	29.20	20.46	4.63
TOTAL LEFT (n = 105)	13.00	37.00	21.47	4.47
RIGHT MALES (n = 53)	11.60	29.50	19.73	4.61
LEFT MALES (n = 53)	13.00	37.00	20.66	4.56
RIGHT FEMALES (n = 52)	11.60	29.20	21.14	4.64
LEFT FEMALES (n = 52)	14.10	29.50	22.22	4.34

JOINT SPACE WIDTH (TABLE 39)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 106)	5.13	9.84	7.45	1.16
TOTAL FEMALES (n = 104)	5.09	8.94	6.54	0.81
TOTAL RIGHT (n = 105)	5.09	9.84	7.15	1.1
TOTAL LEFT (n = 105)	5.13	9.73	6.81	1.06
RIGHT MALES (n = 53)	5.09	8.94	7.61	1.24
LEFT MALES (n = 53)	5.13	9.73	7.30	1.08
RIGHT FEMALES (n = 52)	5.09	8.94	6.72	0.77
LEFT FEMALES (n = 52)	5.20	7.86	6.35	0.82

ANTERIOR ACETABULAR SECTOR ANGLE (TABLE 40)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	56.80	83.60	69.20	6.02
TOTAL FEMALES (n = 104)	53.20	96.00	68.86	8.46
TOTAL RIGHT (n = 105)	53.20	96.00	69.08	8.59
TOTAL LEFT (n = 105)	57.90	84.80	68.97	5.96
RIGHT MALES (n = 53)	53.20	96.00	68.59	6.00
LEFT MALES (n = 53)	57.90	93.60	69.80	6.10
RIGHT FEMALES (n = 52)	53.20	96.00	69.53	10.53
LEFT FEMALES (n = 52)	58.20	84.80	68.19	5.83

POSTERIOR ACETABULAR SECTOR ANGLE (TABLE 41)

GROUPS	MINIMUM(°)	MAXIMUM(°)	MEAN(°)	S.D(°)
TOTAL MALES (n = 106)	62.20	135.70	106.08	12.87
TOTAL FEMALES (n = 104)	85.40	125.20	108.35	8.53
TOTAL RIGHT (n = 105)	62.20	132.60	105.72	12.11
TOTAL LEFT (n = 105)	91.30	135.70	108.80	9.29
RIGHT MALES (n = 53)	85.40	125.20	104.42	14.36
LEFT MALES (n = 53)	91.30	135.70	107.75	11.23
RIGHT FEMALES (n = 52)	95.40	124.80	106.93	9.73
LEFT FEMALES (n = 52)	97.00	125.20	109.76	7.15

TOTAL (BOTH MALES & FEMALES, RIGHT & LEFT):(n = 100) (TABLE 42):

S.NO	PARAMETERS	MINIMUM	MAXIMUM	MEAN	S.D.
1.	**CE angle(^{0})**	33.00	54.40	43.09	4.33
2.	**AD(mm)**	11.18	25.28	19.19	2.77
3.	**AA(^{0})**	31.60	44.80	38.65	2.77
4.	**ARO(^{0})**	5.20	21.80	12.30	3.21
5.	**AIA(^{0})**	13.90	39.30	26.11	4.92
6.	**RA(^{0})**	14.30	28.10	19.05	2.83
7.	**DTW**	0.21	0.43	0.32	0.04
8.	**EI**	0.07	0.26	0.13	0.03
9.	**LS(mm)**	2.71	9.13	5.68	1.27
10.	**PED(mm)**	12.80	24.97	18.94	2.53
11.	**AV(^{0})**	9.70	37.00	20.97	4.55
12.	**JSW(mm)**	5.09	9.84	6.98	1.09
13.	**AASA(^{0})**	53.20	96	69.02	7.35
14.	**PASA(^{0})**	62.20	135.70	107.26	10.85

S.NO	AGE GROUPS (years)	CEA		AD (mm)		AA		ARO		AIA	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1.	**18 to 29**	41.72	4.64	19.25	2.00	40.14	2.06	13.04	3.79	28.60	5.16
2.	**30 to 39**	44.84	5.36	20.47	1.22	38.51	4.31	11.49	2.33	27.04	3.73
3.	**40 to 49**	43.11	3.54	19.55	2.78	37.45	2.82	11.37	2.74	26.05	3.59
4.	**50 to 59**	44.67	4.66	19.83	2.85	39.12	1.84	12.27	3.47	25.18	4.10
5.	**> 60**	41.93	3.55	18.11	3.06	38.11	3.00	12.61	3.10	25.47	5.98

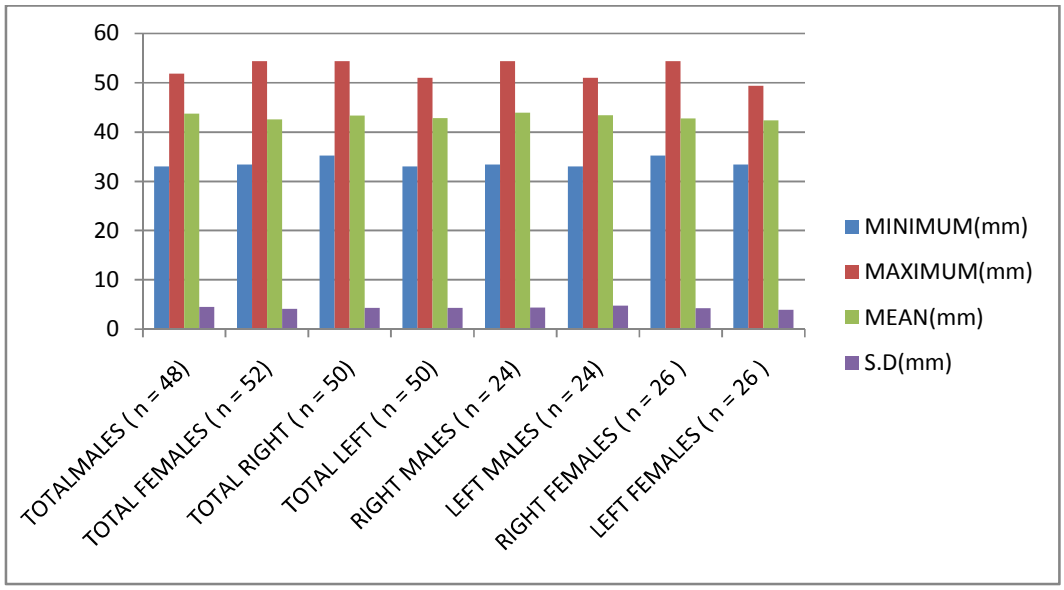
Table 43 a: Acetabular parameters in CT , observed under different age groups

S.NO	AGE GROUPS (years)	RA		DTW		EI		LS (mm)		PED(mm)	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1.	**18 to 29**	18.84	2.04	0.32	0.03	0.15	0.05	5.63	1.70	18.64	2.64
2.	**30 to 39**	22.56	3.10	0.33	0.02	0.13	0.02	5.14	0.80	18.78	1.59
3.	**40 to 49**	19.08	3.70	0.32	0.03	0.13	0.03	5.64	1.04	19.33	2.47
4.	**50 to 59**	18.42	1.83	0.33	0.04	0.13	0.03	5.57	1.02	18.67	2.66
5.	**> 60**	18.81	2.87	0.29	0.04	0.13	0.03	5.95	1.42	19.17	2.66

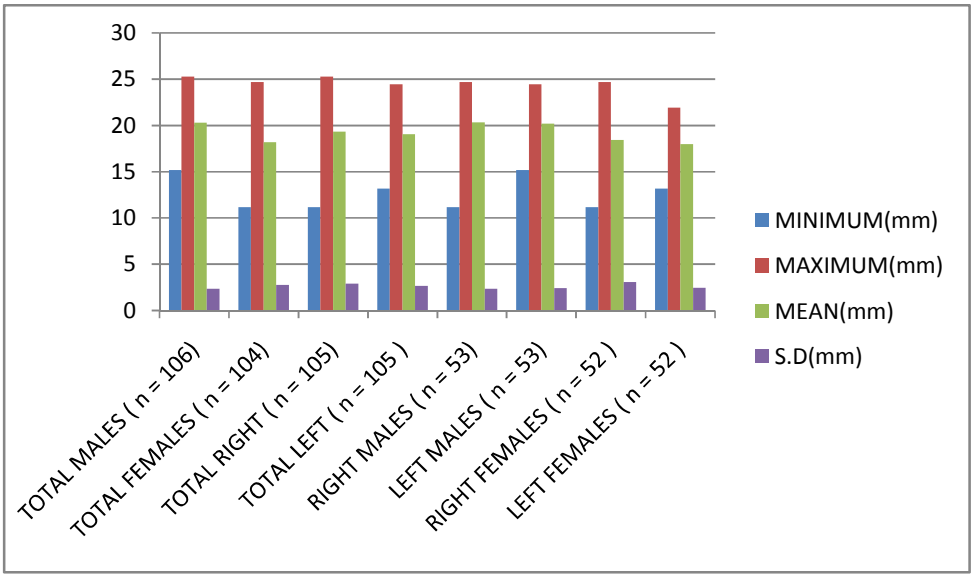
S.NO	AGE GROUPS (years)	AV		JSW (mm)		AASA		PASA	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1.	**18 to 29**	20.24	5.01	7.26	1.31	67.01	6.43	105.86	11.03
2.	**30 to 39**	21.10	2.22	7.13	1.21	67.34	4.63	103.99	7.17
3.	**40 to 49**	18.97	4.35	7.44	1.06	68.91	8.05	104.00	14.19
4.	**50 to 59**	22.36	5.24	6.71	0.92	69.38	7.12	110.20	10.96
5.	**> 60**	21.07	3.99	6.81	1.06	70.19	8.24	107.84	9.28

Table 43 b: Acetabular parameters in X RAYS , observed under different age groups

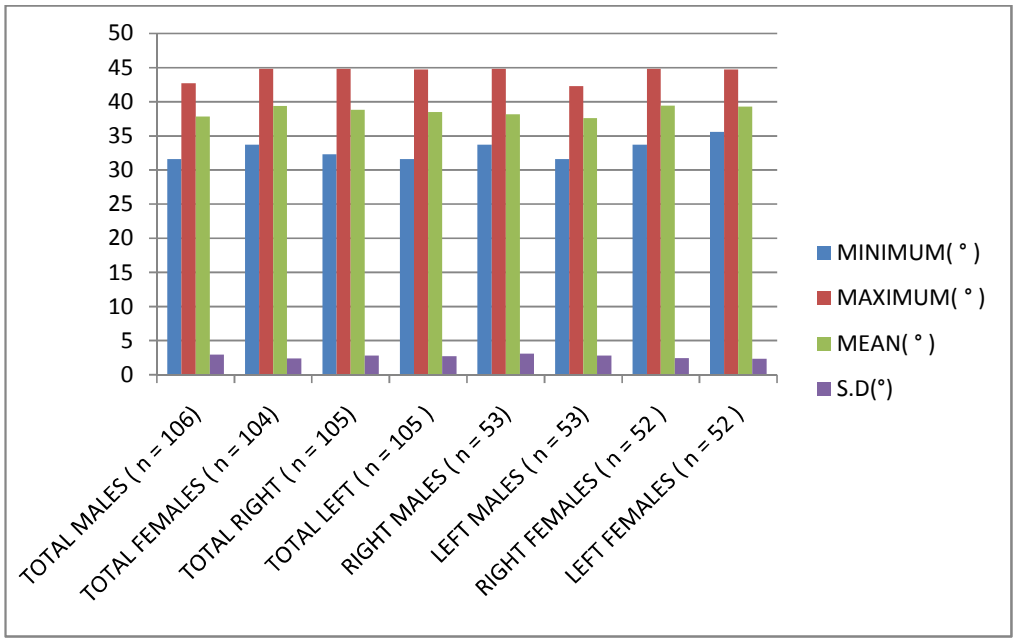
(GRAPHS FOR ACETABULARPARAMETERS IN CT)



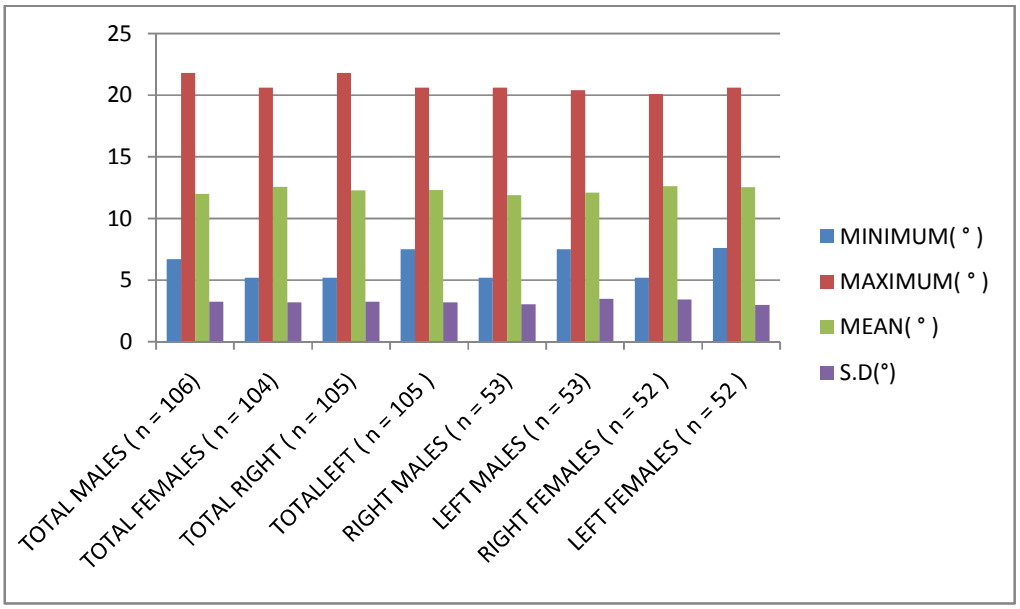
(Graph 23 : the mean CE angle in various groups).



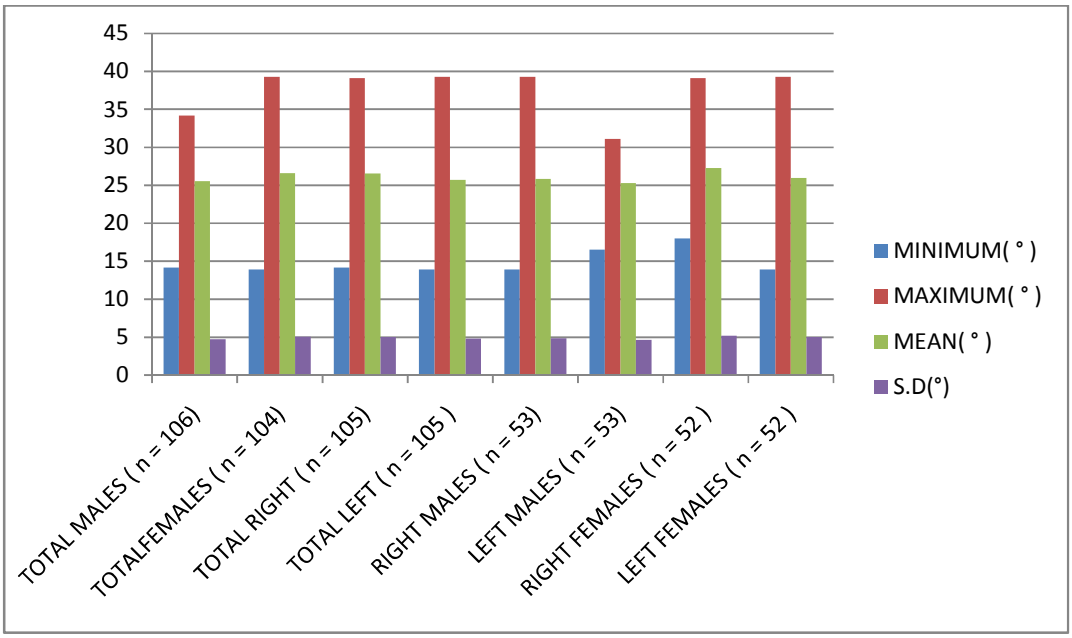
(Graph 24 : The measurements of acetabular depth in various groups).



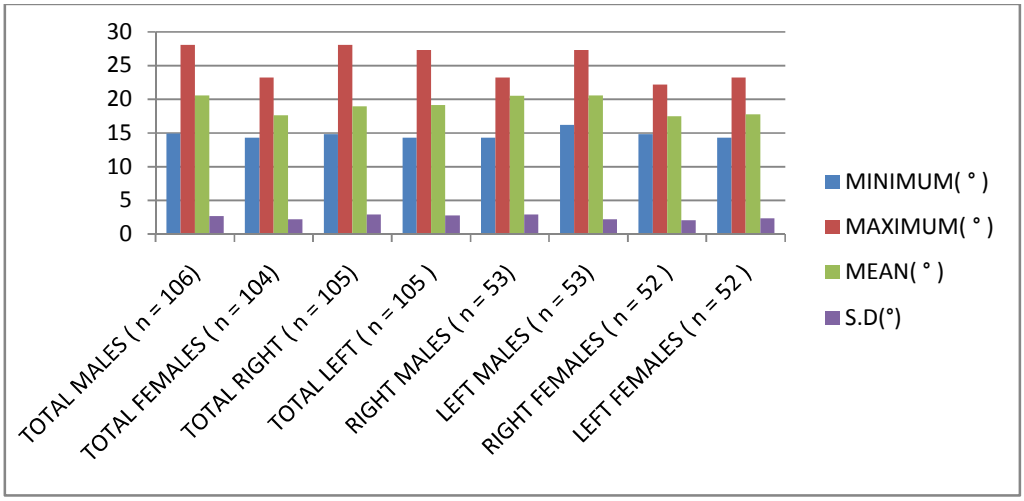
(Graph 25 : The measurements of acetabular angle in different groups).



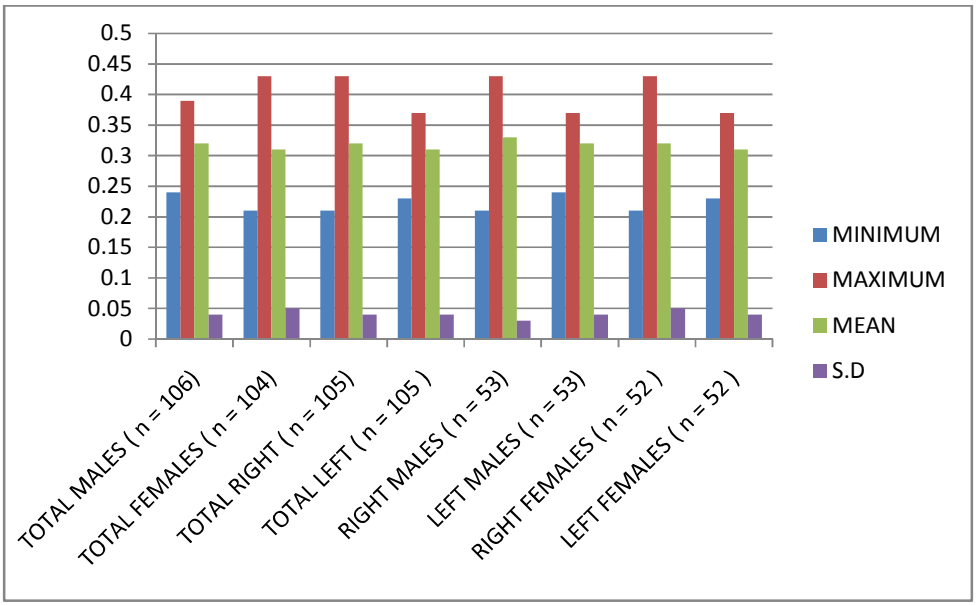
(Graph 26: The min, max, mean and S.D values of acetabular roof obliquity in various groups).



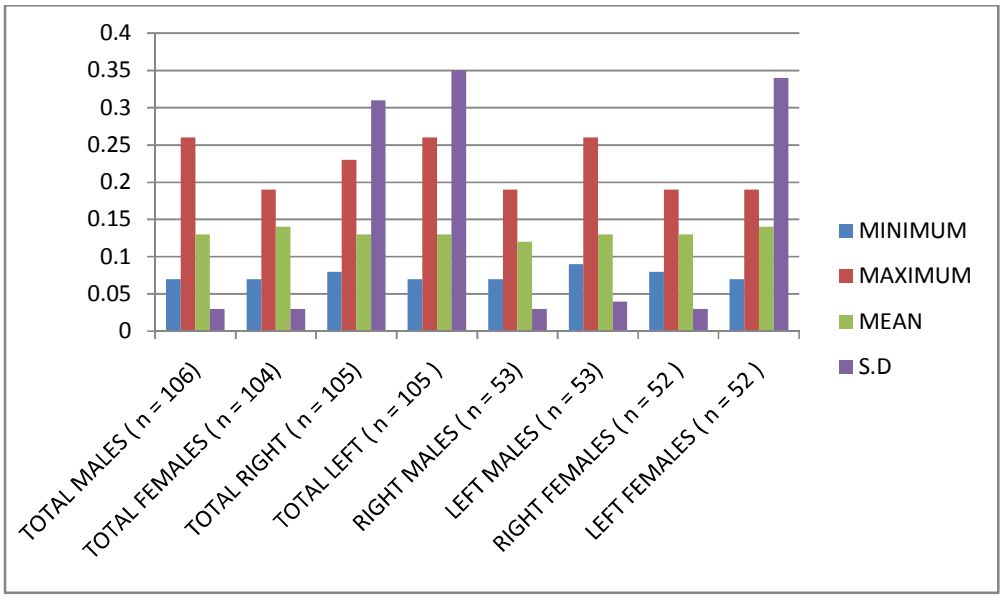
(Graph 27 : The min, max, mean and S.D. of acetabular index angle in various angles).



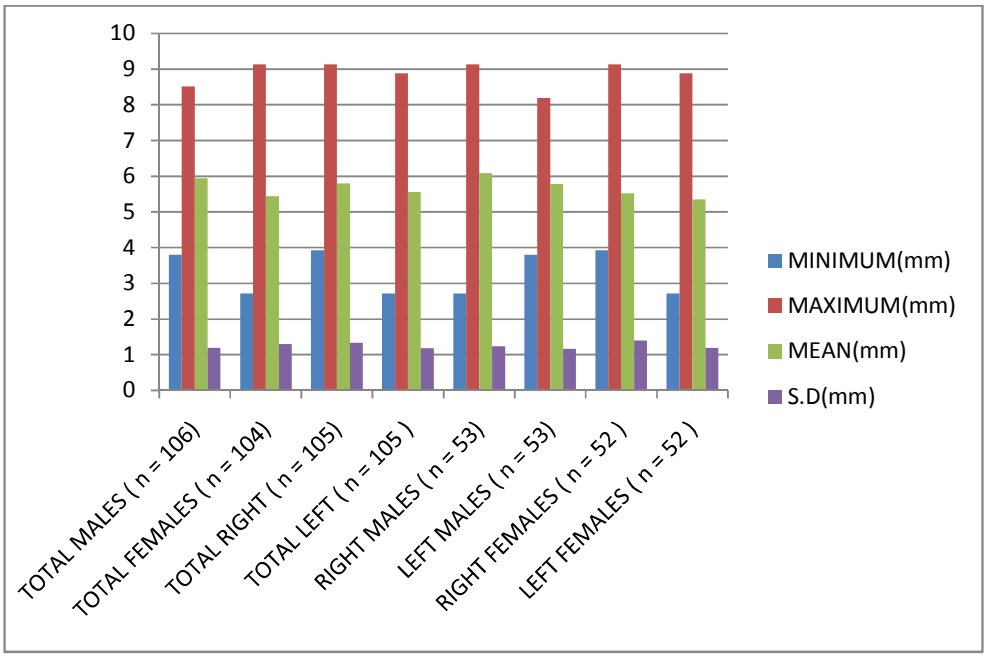
(Graph 28: The measurements of roof angle in various groups)



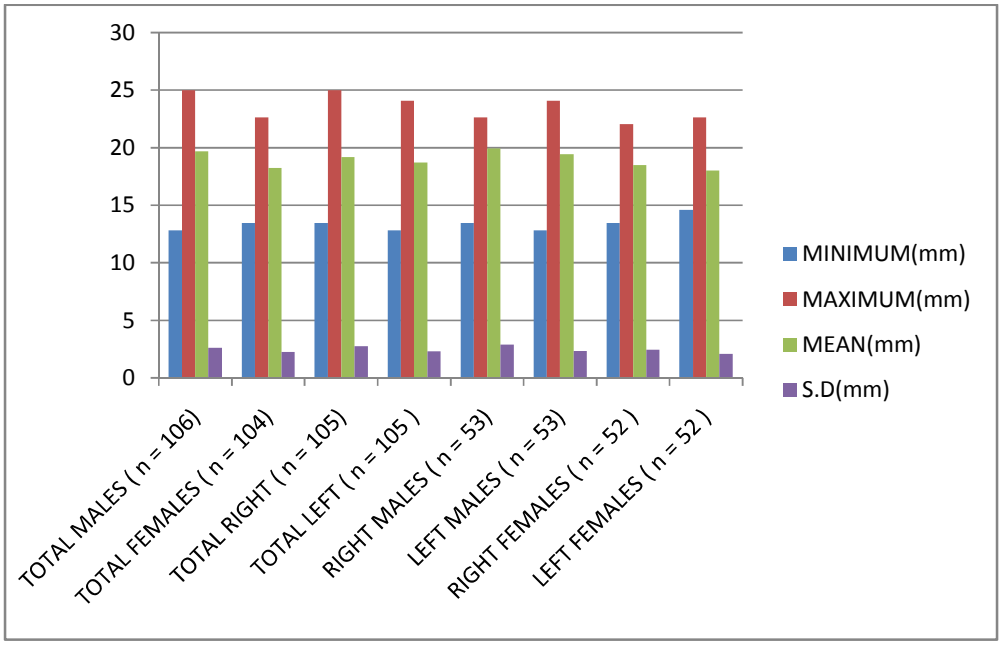
(Graph 29 : The min, max, mean and S.D. values of depth to width ratio in various groups).



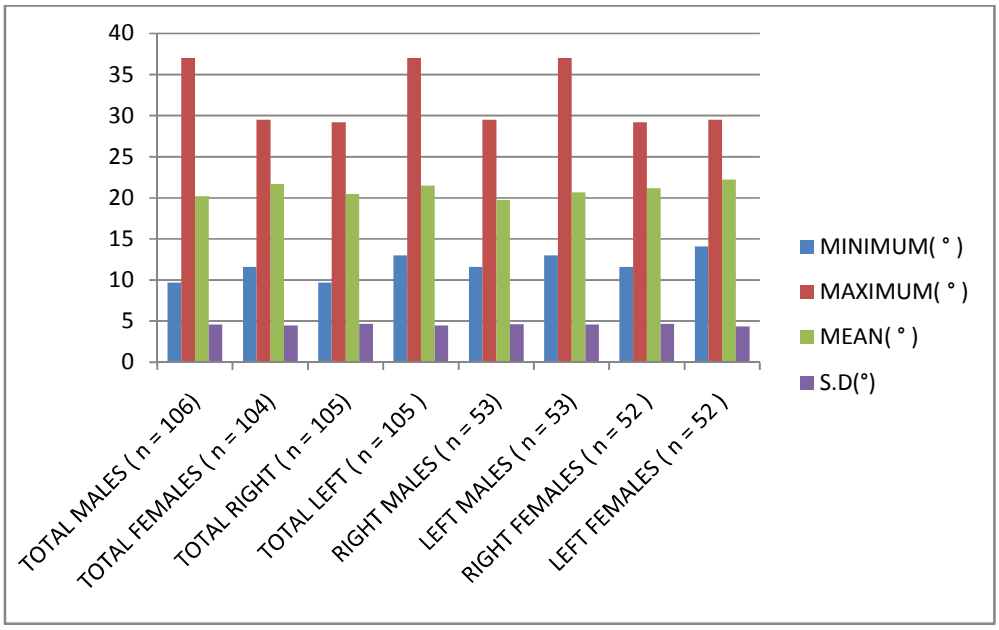
(Graph 30: The measurements of extrusion index in various groups.)



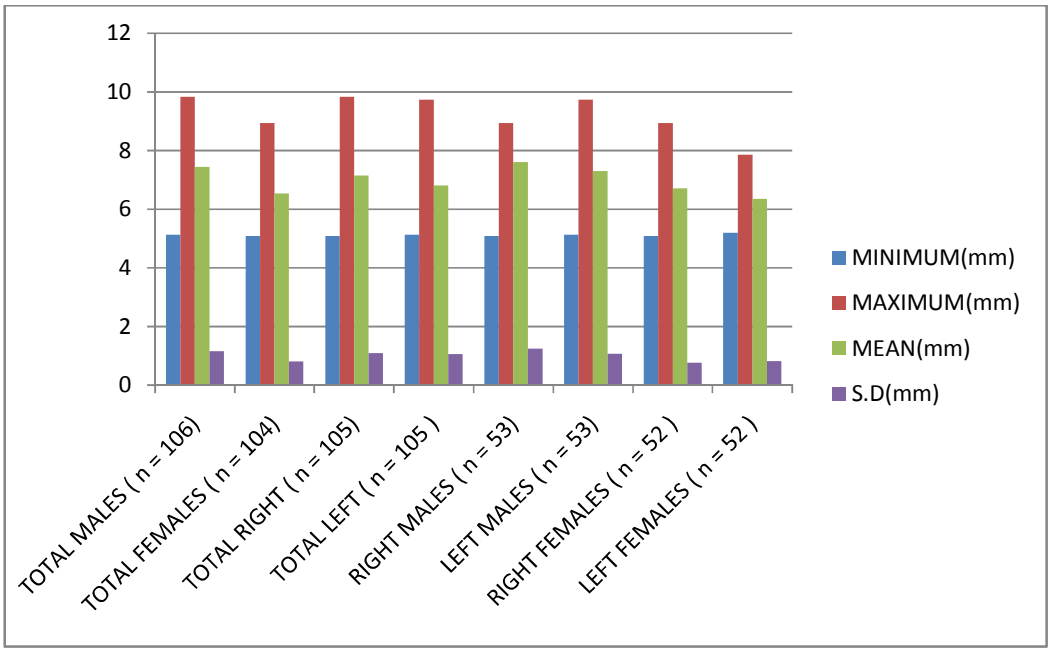
(Graph 31: The min, max, mean and S.D. values of lateral subluxation).



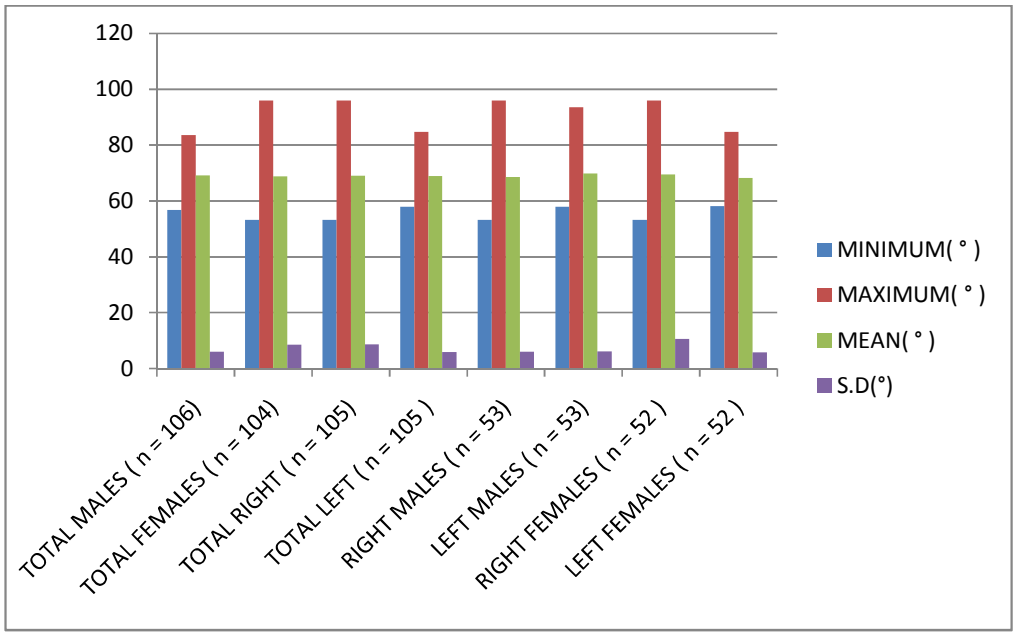
(Graph 32: The measurements of peak to edge distance in various groups).



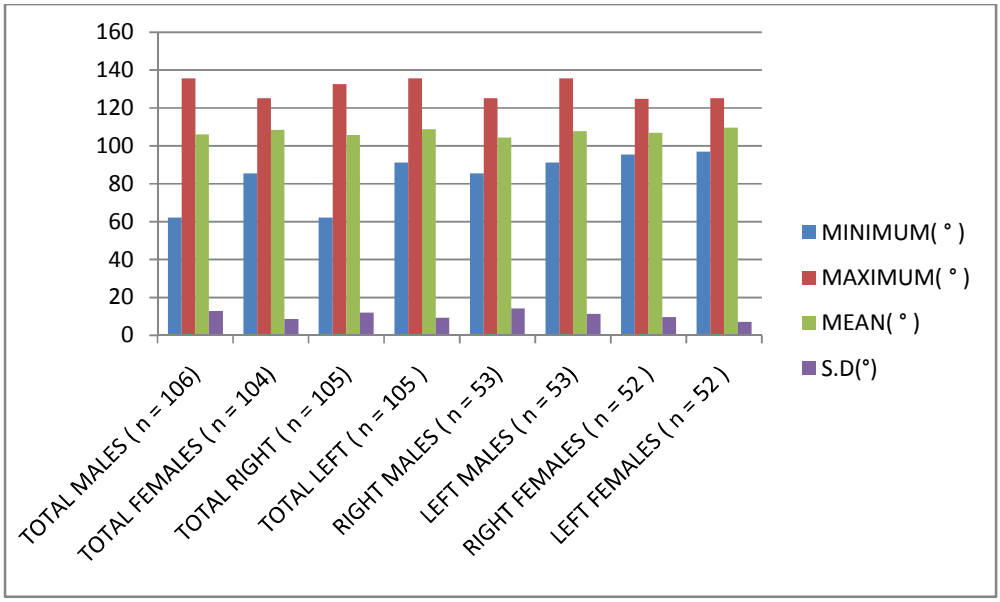
(Graph 33: The measurements of acetabular version in different groups).



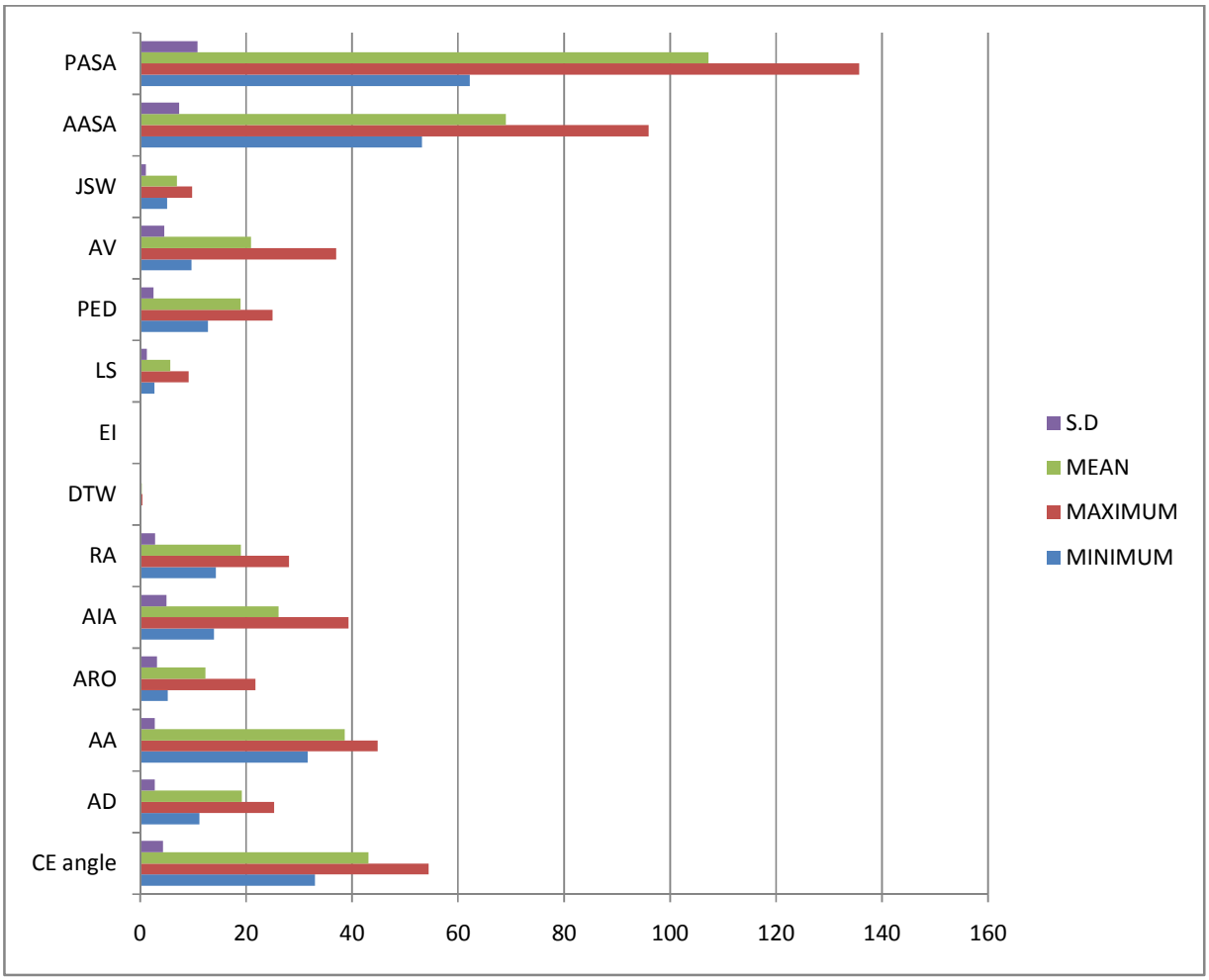
(Graph 34 : The min, max, mean and S.D. values of joint space width in various groups).



(Graph 35 : The min, max, mean and S.D. values of anterior acetabular sector angle in various groups).

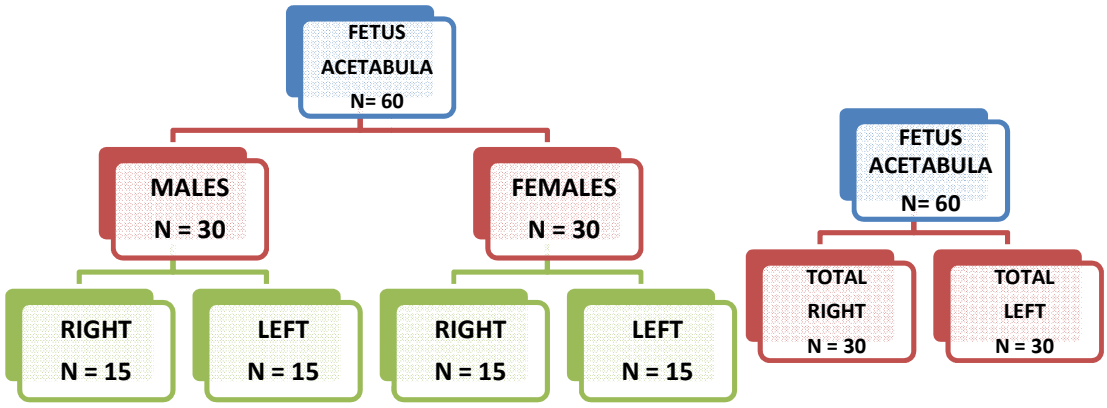


(Graph 36: The min, max, mean and S.D values of posterior acetabular sector angle)



(Graph 37 : The parameters of acetabulum in CT on analysing the total groups).

E) FETUS HIP BONES: (CADAVERIC) (TOTAL ACETABULUM = 60.)



SEX DETERMINATION:	**SIDE DETERMINATION:**
Total number of male hip bones: 30.	Total number of right sided acetabulum : 30.
Total number of female hip bones: 30.	Total number of left sided acetabulum : 30.

SEX AND SIDE DETERMINATION:

Total number of right sided male acetabulum : 15.	Total number of right sided female acetabulum : 15.
Total number of left sided male acetabulum : 15.	Total number of left sided male acetabulum : 15.

ACETABULAR PARAMETERS:

1) Diameter of the acetabulum. 2) Depth of the acetabulum.

3) Shape of the acetabulum.

BASED ON WEEKS:

12 TO 20 weeks (N = 10) , 20 TO 30 weeks (N = 10) , 30 TO 40 weeks (N = 10).

1)DIAMETER OF THE ACETABULUM :

The mean diameter of the acetabulum in males, females, right side, left side ,right side acetabulum of males, left side acetabulum of males, right side acetabulum of females and left side acetabulum of females are 9.35 ± 5.19 mm , 10.29 ± 4.50 mm, 9.82 ± 4.70 mm , 9.82 ± 4.90 mm , 9.33 ± 5.24 mm , 9.37 ± 5.32 mm , 10.31 ± 4.60 mm and 10.27 ± 4.58 mm respectively.**(Table 44) (Graph 38).** The average diameter of the acetabulum in females, right, left side of the males , right side of the females than the males, left, right side of the males, left side of the females respectively.

2)DEPTH OF THE ACETABULUM :

The average depth of the fetal acetabulum in males, females ,right side , left side, right side, left side, right side acetabulum of the males, left side acetabulum of the males, right side acetabulum of the females and left side acetabulum of the females are 4.42 ± 1.84 mm, 4.73 ± 1.35 mm, 4.57 ± 1.62 mm, 4.57 ± 1.62 mm, 4.40 ± 1.85 mm, 4.44 ± 1.89 mm, 4.75 ± 1.38 mm and 4.72 ± 1.37 mm respectively.**(Table 45) (Graph 39).** The mean depth of the acetabulum was more in females, left side of the males and right side of the females than males, right side of the males and left side of the females respectively.right and left side showed equal preponderance.

3)SHAPE OF THE ACETABULUM :

The average value regarding the shape of the acetabulum are 54.87 ± 14.84, 51.15 ± 12.35, 53.00 ± 13.94 , 53.02 ± 13.62 , 54.69 ± 15.29 , 55.06 ± 14.90, 51.31 ± 12.75 and 50.99 ± 12.38 in males, females ,right side, left side, right side, left side, right side acetabulum of the males, left side acetabulum of the males, right side acetabulum of the females and left side acetabulum of the females respectively.**(Table 46) (Graph 40).** The mean shape of the acetabulum in males, left side, right side of the males and right side of the females was more than that of females, right side, left side of the males and left side of the females.

TOTAL:

The average values of diameter, depth and shape of the acetabulum, while calculating for all the fetuses (irrespective of age and sex) are 9.82 ± 4.84 mm, 4.57 ± 1.61 mm , 53.01 ± 13.67 respectively. **(Table 47) (Graph 41).**

COMPARISION OF MEANS BETWEEN DIFFERENT AGE GROUPS:

On comparing the study groups : group A (12 TO 20weeks) , group B (21 TO 30 weeks), group C (31 TO 40 weeks), the diameter and the depth increased, with increase in age of the foetuses but the shape of the acetabulum showed a remarkable change of negative correlation with age and made the acetabular cavity more shallow**. (Table 48, 49, 50) , (Graph 42 , 43 , 44).**

DIAMETER OF THE ACETABULUM (TABLE 44)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n = 30)	1.10	17.11	9.35	5.19
TOTAL FEMALES (n = 30)	2.00	17.01	10.29	4.50
TOTAL RIGHT (n = 30)	1.10	17.01	9.82	4.87
TOTAL LEFT (n = 30)	1.11	17.11	9.82	4.90
RIGHT MALES (n = 15)	1.10	17.01	9.33	5.24
LEFT MALES (n = 15)	1.11	17.11	9.37	5.32
RIGHT FEMALES (n = 15)	2.01	16.90	10.31	4.60
LEFT FEMALES (n = 15)	2.00	17.01	10.27	4.58

DEPTH OF THE ACETABULUM (TABLE 45)

GROUPS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
TOTAL MALES (n =30)	0.88	6.56	4.42	1.84
TOTAL FEMALES (n =30)	1.52	6.50	4.73	1.35
TOTAL RIGHT (n = 30)	0.89	6.50	4.57	1.62
TOTAL LEFT (n = 30)	0.88	6.50	4.57	1.62
RIGHT MALES (n = 15)	0.89	6.49	4.40	1.85
LEFT MALES (n = 15)	0.88	6.56	4.44	1.89
RIGHT FEMALES (n = 15)	1.56	6.50	4.75	1.38
LEFT FEMALES (n = 15)	1.52	6.25	4.72	1.37

SHAPE OF THE ACETABULUM (TABLE 46)

GROUPS	MINIMUM	MAXIMUM	MEAN	S.D
TOTAL MALES (n = 30)	38.15	80.90	54.87	14.84
TOTAL FEMALES (n = 30)	36.74	77.61	51.15	12.35
TOTAL RIGHT (n = 30)	37.20	80.90	53.00	13.94
TOTAL LEFT (n = 30)	36.74	80.00	53.02	13.62
RIGHT MALES (n = 15)	38.15	80.90	54.69	15.29
LEFT MALES (n = 15)	38.34	80.00	55.06	14.90
RIGHT FEMALES (n = 15)	37.20	77.61	51.31	12.75
LEFT FEMALES (n = 15)	36.74	76.00	50.99	12.38

TOTAL (n = 60): (TABLE 47)

S.NO	PARAMETERS	MINIMUM(mm)	MAXIMUM(mm)	MEAN(mm)	S.D(mm)
1.	Diameter (a1)	1.10	17.11	9.82	4.84
2.	Depth (a2)	0.88	6.56	4.57	1.61
3.	Shape (a2 / a1 *100	36.74	80.90	53.01	13.67

COMPARISON BETWEEN DIFFERENT AGE GROUPS IN WEEKS

DIAMETER (mm) (TABLE 48)

S.NO	GROUPS	12 – 20 weeks	21 -30 weeks	31 – 40 weeks
1.	TOTAL	3.90 ± 1.89	10.69 ± 1.65	14.88 ± 1.40
2.	TOTAL MALES	3.05 ± 1.83	10.13 ± 1.64	14.86 ± 1.53
3.	TOTAL FEMALES	4.75 ± 1.63	11.25 ± 1.56	14.88 ± 1.36
4.	TOTAL RIGHT	3.91± 1.96	10.71 ± 1.76	14.83 ± 1.44
5.	TOTAL LEFT	3.88± 1.94	10.67 ± 1.64	14.91±1.46
6.	RIGHT MALES	3.07 ± 1.95	10.12 ± 1.72	14.79 ± 1.65
7.	LEFT MALES	3.03 ± 1.93	10.15 ± 1.76	14.93 ± 1.60
8.	RIGHT FEMALES	4.75 ± 1.75	11.31 ± 1.78	14.88 ± 1.40
9.	LEFT FEMALES	4.74 ± 1.71	11.19 ± 1.52	14.89 ± 1.49

DEPTH (mm) (TABLE 49)

S.NO	GROUPS	12 – 20 weeks	21 -30 weeks	31 – 40 weeks
1.	**TOTAL**	2.64 ± 1.10	4.99 ± 0.45	6.09 ± 0.28
2.	**TOTAL MALES**	2.19 ± 1.15	4.86 ± 0.46	6.21 ± 0.29
3.	**TOTAL FEMALES**	3.09 ± 0.89	5.13 ± 0.43	5.98 ± 0.25
4.	**TOTAL RIGHT**	2.66± 1.14	4.96 ± 0.47	6.10 ± 0.29

5.	**TOTAL LEFT**	2.63± 1.13	5.02 ± 0.47	6.08 ± 0.30
6.	**RIGHT MALES**	2.20 ± 1.20	4.80 ± 0.46	6.18 ± 0.30
7.	**LEFT MALES**	2.18 ± 1.22	4.91 ± 0.50	6.24 ± 0.31
8.	**RIGHT FEMALES**	3.12 ± 0.94	5.12 ± 0.47	6.02 ± 0.29
9.	**LEFT FEMALES**	3.08 ± 0.94	5.14 ± 0.46	5.94 ± 0.22

SHAPE (TABLE 50)

S.NO	GROUPS	12 – 20 weeks	21 -30 weeks	31 – 40
1.	**TOTAL**	70.69 ± 6.59	47.29± 3.20	41.05 ± 3.47
2.	**TOTAL MALES**	74.26 ± 5.18	48.44 ± 3.72	41.92 ± 4.31
3.	**TOTAL FEMALES**	67.12 ± 6.04	46.15± 2.21	40.18 ± 2.26
4.	**TOTAL RIGHT**	70.91 ± 6.91	47.06 ± 3.21	41.01 ± 3.56
5.	**TOTAL LEFT**	70.47 ± 6.61	47.52 ± 3.35	41.08 ± 3.57
6.	**RIGHT MALES**	74.32 ± 5.80	48.01 ± 3.97	41.74 ± 4.65
7.	**LEFT MALES**	74.21 ± 5.28	48.87 ± 3.87	42.10 ± 4.49
8.	**RIGHT FEMALES**	67.51 ± 6.73	46.11 ± 2.30	40.30 ± 2.35
9.	**LEFT FEMALES**	66.73 ± 6.05	46.18 ± 2.39	40.06 ± 2.43

COMPARISION OF MEANS BETWEEN DIFFERENT TRIMESTERS

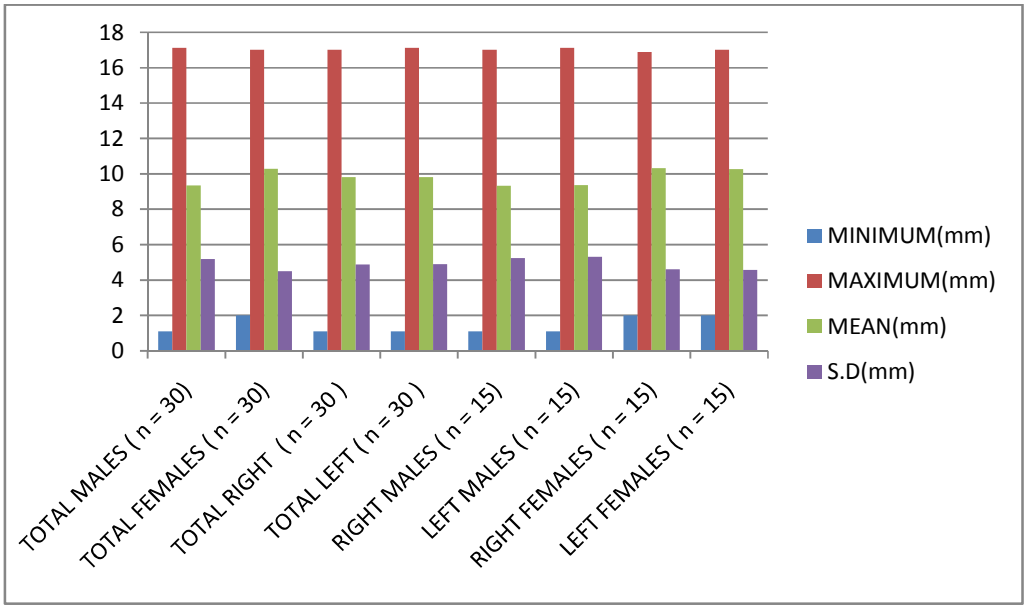
S.No	Parameters	Second Trimester		Third Trimester		2 nd Trimester: Total Mean N=13	3 rd Trimester: Total Mean N=17	Second And Third Trimester Total Mean N= 30	Total Mean (Males) N= 15	Total Mean (Females) N= 15
		Males N=7	Females N= 6	Males N=8	Females N=9					
1.	Acetabular depth(mm)	2.81 ± 1.44	3.33 ± 1.00	5.79 ± 0.59	5.70 ± 0.47	3.05± 1.24	5.74 ± 0.51	4.57 ± 1.62	4.40 ± 1.85	4.75 ± 1.38
2.	Acetabular diameter(mm)	4.57 ± 3.02	5.44 ± 2.30	13.49 ± 2.20	13.56 ± 2.02	4.98 ± 2.64	13.52 ± 2.04	9.82 ± 4.87	9.33 ± 5.25	10.31 ± 4.60

Table 51 a : Acetabular parameters in right side of fetuses .

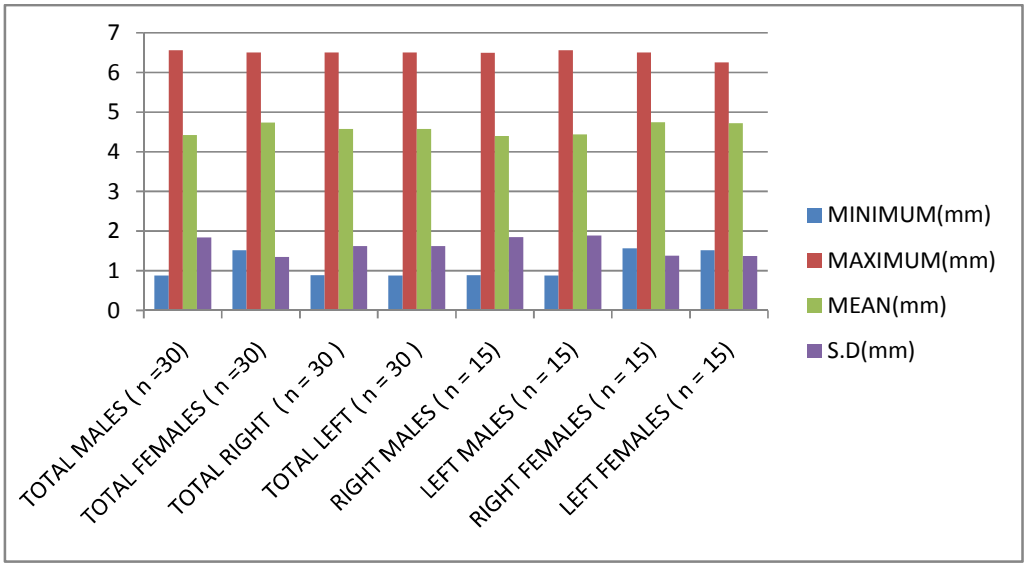
S.No	Parameters	Second Trimester :		Third Trimester		2 nd Trimester: Total Mean N=13	3 rd Trimester: Total Mean N=17	Second And Third Trimester Total Mean N= 30	Total Mean (Males) N= 15	Total Mean (Females) N= 15
		Males N=7	Females N= 6	Males N=8	Females N=9					
1.	Acetabular depth(mm)	2.81 ± 1.46	3.31 ± 1.01	5.87 ± 0.56	5.66 ± 0.41	3.04 ± 1.25	5.76 ± 0.48	4.58 ± 1.63	4.44 ± 1.89	4.72 ± 1.37
2.	Acetabular diameter(mm)	4.53 ± 3.03	5.44 ± 2.30	13.60 ± 2.21	13.49 ± 2.05	4.95 ± 2.65	13.55 ± 2.06	9.82 ± 4.90	9.37 ± 5.32	10.27 ± 4.58

Table 51 b : Acetabular parameters in left side of fetuses

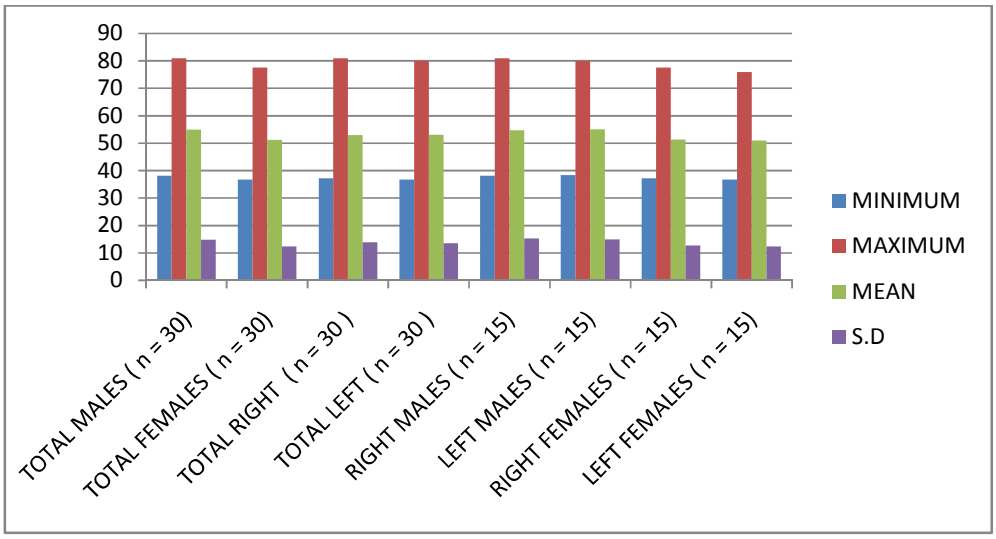
(GRAPHS FOR ACETABULARPARAMETERS IN FETUS)



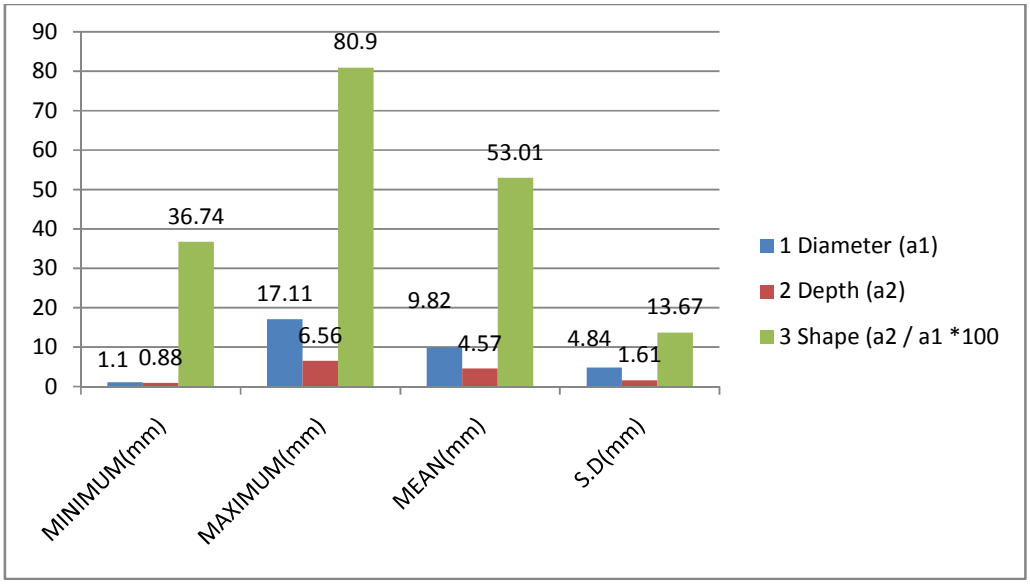
(Graph 38 : The measurements of the diameter of fetus acetabulum in various groups)



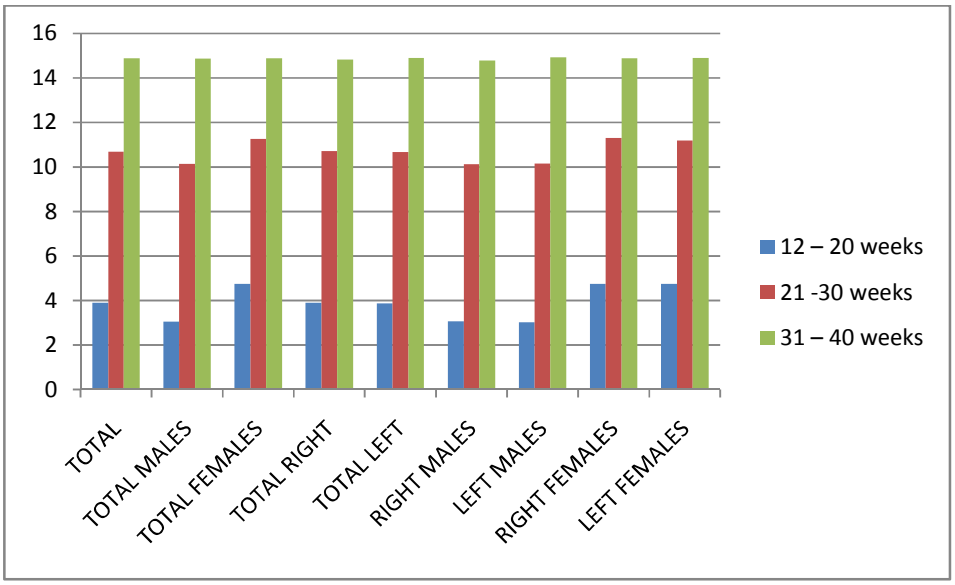
(Graph 39: The min, max, mean and S.D of depth in fetus acetabulum in various groups).



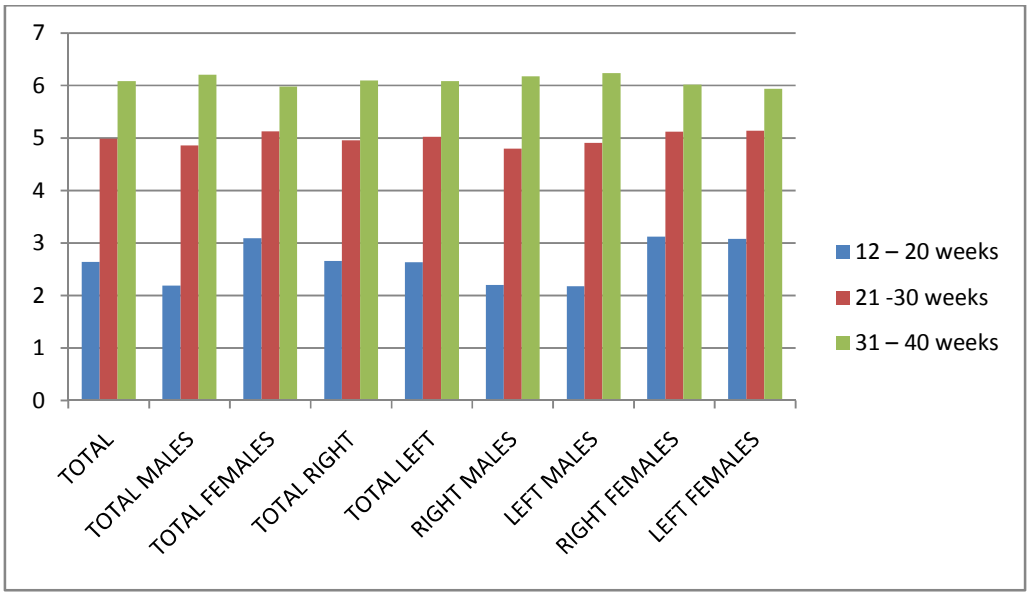
(Graph 40 : The measurements regarding the shape of fetus acetabulum in various groups).



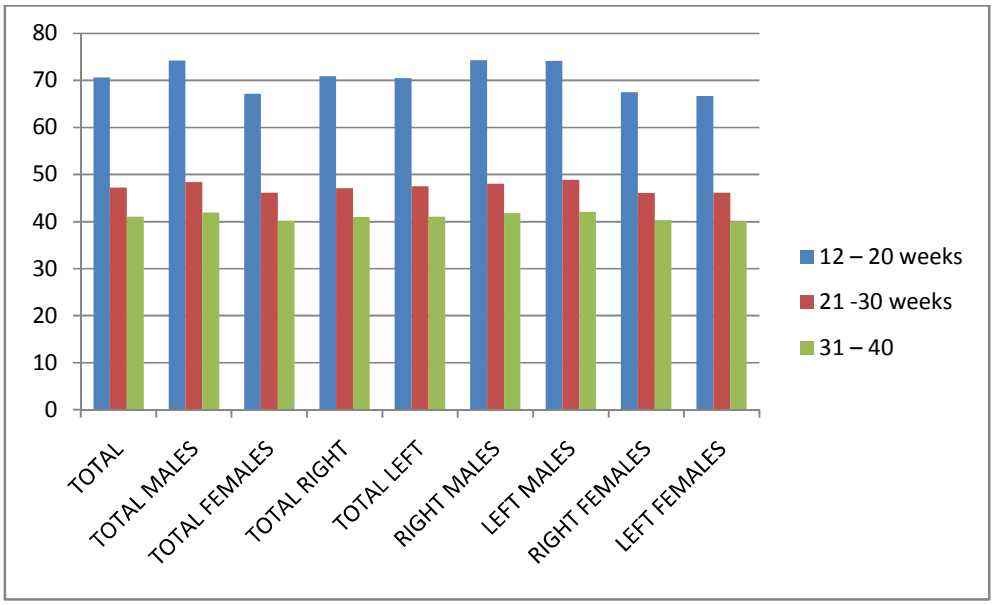
(Graph 41: The total values of diameter, depth and shape of the fetus acetabulum).



(Graph 42: The measurements of diameter in different groups and various age groups).



(Graph 43 : The measurements of depth in various age groups under different groups).



(graph 44 : Measurements of shape of the acetabulum in various age groups under different divisible groups.)

STATISTICAL ANALYSIS:

Based on the observations made in the Dry, Cadaveric, X rays, CT and fetus acetabula, we applied the results in IBM SPSS software (version 19) for statistical analysis. The tests implied were

1) **Independent t test (unpaired t test).**

   To test the significance of the observed parameters in accordance with age and gender.

2) **One way ANOVA.**

   To test the influence of one parameter over the other and assess its significance within and with other groups.

3) **Pearson's correlation test. (r – correlation coefficient)**

   To test the correlation of the significant parameters with that of the others.

The analysis results were:

1) DRY ACETABULA:

On assessing total 100 dry acetabula (N = 100) (groups : 53 male, 47 female, 46 right, 54 left acetabula , 29 right side of males, 24 left side of males, 17 ride side of females and 30 left side of females) with the diameter , depth and capacity ,for all the parameters we had a strong statistical significance between

1) males and females ($p < 0.001$) , **(Annexure 1 - Table 52 , 53 , 54)**
2) right side of males and right side of females ($p < 0.001$) **,** left side of males and left side of females ($p < 0.001$) **(Annexure 1 - Table 55 , 56 , 57)**

Whereas the rest of the groups (based on side) were statistically insignificant.

Based on the Pearson's coefficient **(Annexure 1 - Table 58)** all the three parameters correlate positive with each other. Between diameter and depth r value is 0.603 with P < 0.01 (strong positive) , between diameter and capacity r value is 0.589 with P < 0.01 (strong positive) , between the depth and the capacity r value is 0.536 with P < 0.01 (strong positive).

2)CADAVERIC ACETABULA:

In the total of 30 (N = 30) cadaveric acetabula (GROUPS: 15 Males, 15 females , 16 right side , 14 left side , 8 right side of males , 7 left side of males , 8 right side of females and 7 left side of females) were analyzed for diameter , depth and capacity and for all the parameters , there was statistical significance in

1) males and females ($p < 0.001$) , **(Annexure 2 - Table 59 , 60 , 61)**

2) right side of males and right side of females ($p < 0.001$) , left side of males and left side of females ($p < 0.001$) **(Annexure 2 - Table 62 , 63 , 64)**

Whereas the rest of the groups (based on side) were statistically insignificant.

1) Based on the Pearson's coefficient **(Annexure 2 - Table 65)** all the three parameters correlate positive with each other. Between diameter and depth r value is 0.406 with P < 0.01 (strong positive) , between diameter and capacity r value is 0.511 with p < 0.05 (strong positive) , between the depth and the capacity r value is 0.537 with P < 0.01 (strong positive).

3)X RAYS ACETABULA:

In the total number of 210 (N = 210) acetabula (GROUPS: 106 male , 104 female , 105 right , 105 left acetabula , 53 right side of males , 53 left side of males , 52 right side of females and 52 left side of females) with parameters like CE angle , AD , AA , ARO , AIA , RA , DTW , EI , LS , PED and JSW were statistically assessed. Strong statistical significance was found between the males and females in parameters like **CE angle (P = 0.011), AD (P < 0.001), RA (P < 0.001), LS (P < 0.001), PED (P < 0.001) and JSW (P < 0.001). (Annexure 3 - Table 66).**These parameters had no statistical significance with respect to side and rest of the parameters were statistically insignificant for both gender as well as side. In case of comparing right side of males and right side of females for the statistically significant parameters , there were high significance ($p < 0.001$) , on comparing the left side of males with that of left side of females there was also high significance with the P values of $P < 0.001$ for AD , $P = 0.001$ for RA , $P = 0.002$ for LS , $P = 0.011$ for PED , $P < 0.001$ for JSW.CE angle does not have significance in the subgroups right males and right females , left males and left females. **(Annexure 3 - Table 67).**

On assessing the correlation of the above significant parameters with that of other parameters by Pearson's coefficient **(Annexure 3 - Table 68)** is such that

1) CE angle had very weak positive correlation with PED ($r = 0.168$, $P < 0.05$) , weak positive correlation with LS ($r = 0.214$, $P < 0.01$) , very weak positive correlation with RA ($r = 0.196$, $P < 0.01$) and negative correlation with AIA ($r = - 0.249$, $P < 0.01$).

2) AD had moderate positive correlation with PED (r = 0.350, P < 0.01), weak positive correlation with LS (r = 0.206, P < 0.01) and weak positive correlation with DTW (r = 0.211, P < 0.01).
3) RA had very weak positive correlation with CE angle (r = 0.196, P < 0.01), very weak positive correlation with EI (r = 0.182, P < 0.05), weak positive correlation with DTW (r = 0.223, P < 0.01) and very weak positive correlation with AIA (r = 0.153, P < 0.05).
4) LS had weak positive correlation with JSW (r = 0.275, P < 0.01), very weak positive correlation with PED (r = 0.141, P < 0.05), weak positive correlation with AD (r = 0.206 , P < 0.01) , weak positive correlation with CE angle (r = 0.214, P < 0.01).
5) PED had very weak positive correlation with CE angle (r = 0.168, P < 0.05), moderate positive correlation with AD (r = 0.350, P < 0.01) and very weak positive correlation with LS (r = 0.141, P < 0.01).
6) JSW had weak positive correlation with LS (r = 0.275, P < 0.01).

Based on this result, we observed the difference of measurement with respect to the gender for the significant parameters in X rays , under different age groups in the following **Tables 69 , 70.**

S.NO	AGE GROUPS	CEA		AD		RA		LS		PED		JSW	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1.	18 to 29	41.66	3.25	23.21	2.87	18.25	1.11	7.65	0.75	19.85	2.18	6.99	0.93
2.	30 to 39	43.40	2.69	21.63	2.66	19.85	2.28	8.02	1.12	19.67	2.05	8.21	1.75
3.	40 to 49	41.72	2.52	20.81	1.83	19.69	1.91	7.97	1.24	18.91	2.83	7.72	0.88
4.	50 to 59	43.12	2.59	22.55	2.83	19.35	1.97	9.14	1.49	19.09	2.92	9.28	0.98
5.	> 60	45.18	3.51	22.23	2.62	20.40	2.05	8.75	1.35	19.21	1.78	9.05	0.76

Table 69 : Significant acetabular parameters in X RAYS , observed under different age groups (MALES)

S.NO	AGE GROUPS	CEA		AD		RA		LS		PED		JSW	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1.	18 to 29	43.89	2.13	20.35	1.57	18.43	3.03	6.61	1.50	19.68	1.43	6.38	0.43
2.	30 to 39	42.03	2.32	19.87	1.44	18.24	1.94	6.90	1.57	17.44	1.96	7.52	0.69
3.	40 to 49	41.40	2.97	19.49	1.97	17.27	1.28	7.40	1.04	17.44	3.09	7.94	0.90
4.	50 to 59	42.02	2.00	20.12	1.54	17.98	1.40	7.87	1.50	17.74	2.94	7.48	1.23
5.	> 60	41.72	1.29	20.30	0.94	19.70	2.85	8.06	0.52	16.99	1.65	8.87	0.84

Table 70 : Significant acetabular parameters in X RAYS , observed under different age groups (FEMALES)

4)CT ACETABULA:

In total number of 100 (N = 100) acetabula (GROUPS: 48 male, 52 female, 50 right, 50 left, 24 right side of males, 24 left side of males, 26 right side of females and 26 left side of females), with parameters like CE angle, AD, AA, ARO, AIA, RA, DTW, EI, LS, PED, AV, JSW, AASA and PASA were statistically analyzed. Strong statistical significance was found between the males and females in parameters like **AD (P < 0.001), RA (P < 0.001) , AA (P = 0.006) , LS (P = 0.05) , PED (P = 0.004) and JSW (P < 0.001). (Annexure 4 - Table 71).** These parameters had no statistical significance with respect to side and rest of the parameters were statistically insignificant for both gender as well as side. In case of comparing right side of males and right side of females for the statistically significant parameters, there were high significance with P values of P = 0.011 for AD, P < 0.001 for RA , P = 0.037 for PED and P < 0.001 for JSW ; except for AA which was insignificant , on comparing the left side of males with that of left side of females there was also high significance with the P values of P = 0.011 for AD, P < 0.026 for AA , P < 0.001 for RA, P < 0.05 for PED, P < 0.001 for JSW; except for LS which was insignificant. **(Annexure 4 - Table 72).**

On assessing the correlation of the above significant parameters with that of other parameters by Pearson's correlation test **(Annexure 4 - Table 73)** is such that

1) AD had moderate positive correlation with CE angle (r = 0.350, P < 0.01) , very strong positive correlation with DTW (r = 0.763, P < 0.01),strong positive correlation with PED (r = 0.504, P < 0.01) and had negative correlation with AA (r = - 0.225, P < 0.05) , ARO (r = - 0.290, P < 0.05) and AIA (r = - 0.294, P < 0.01).

2) AA had negative correlation with CE angle (r = - 0.279, P < 0.01), negative correlation with AD (r = - 0.225 , P < 0.05) and moderate positive correlation with ARO (r = 0.303, P < 0.01), weak positive correlation with AIA (r = 0.241, P < 0.01) and weak positive correlation with EI (r = 0.241, P < 0.01).
3) RA had no significant correlation with rest of the parameters.
4) LS had negative correlation with EI (r = - 0.252, P < 0.05) and weak positive correlation with PED (r = 0.252, P < 0.01), weak positive correlation with JSW (r = 0.298, P < 0.01).
5) PED had weak positive correlation with CE angle (r = 0.206, P < 0.05), strong positive correlation with AD (r = 0.504, P < 0.01) and moderate positive correlation with DTW (r = 0.355, P < 0.01) , had negative correlation with EI (r = - 0.355, P < 0.01) and ARO (r = - 0.232, P < 0.01).
6) JSW had weak positive correlation with LS (r = 0.298, P < 0.01) and negative correlation with AASA (r = - 0.225, P < 0.01) and PASA (r = - 0.273, P < 0.01).

Based on this result , we observed the difference of measurement with respect to the gender for the significant parameters in the CT , under different age groups in the following **Tables 74 , 75.**

S.NO	AGE GROUPS	AD		AA		RA		LS		PED		JSW	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1.	18 to 29	19.21	1.43	41.00	1.61	19.56	1.49	5.42	0.90	17.06	2.81	8.20	0.94
2.	30 to 39	20.43	1.40	37.18	3.98	22.87	3.59	5.40	0.70	19.44	1.19	7.54	1.09
3.	40 to 49	20.59	2.61	37.01	2.77	19.96	4.39	5.90	1.13	20.18	2.29	7.83	1.06
4.	50 to 59	21.63	2.11	38.86	1.83	19.73	0.79	5.77	0.70	20.17	2.74	6.74	0.96
5.	> 60	19.60	2.77	36.26	2.40	21.19	1.43	6.60	1.59	20.62	2.33	7.26	1.27

Table 74 : Significant acetabular parameters in CT , observed under different age groups (MALES)

S.NO	AGE GROUPS	AD		AA		RA		LS		PED		JSW	
		MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
1.	18 to 29	19.29	2.55	39.28	2.19	18.13	2.36	5.84	2.30	20.21	1.17	6.31	0.87
2.	30 to 39	20.58	0.78	42.50	2.97	21.65	0.64	4.36	0.60	16.80	0.22	5.91	0.56
3.	40 to 49	17.84	2.29	38.18	2.99	17.62	1.48	5.20	0.74	17.91	2.23	6.79	0.70
4.	50 to 59	18.83	2.75	39.27	1.89	17.70	1.85	5.47	1.17	17.83	2.28	6.70	0.92
5.	> 60	16.96	2.82	39.56	2.64	16.96	2.28	5.44	1.05	18.04	2.39	6.47	0.71

Table 75 : Significant acetabular parameters in CT , observed under different age groups (FEMALES)

5)FETUS ACETABULA:

30 fetuses (total number of 60 (N = 60) acetabula) (GROUPS: 30 male , 30 female, 30 right, 30 left, 15 right side of males, 15 left side of males , 15 ride side of females and 15 left side of females) were assessed for the diameter , depth and shape ,for all the parameters we had a no statistical significance between the males and females as well as between the right side and left side. But on including age as a criteria for assessing the significance of the parameters , we observed that there was a strong statistical significance for diameter , depth and shape with age ($p < 0.001$) [both when classified as based on difference of ten weeks (12 to 20 , 20 to 30 , 30 to 40) **(Annexure 5 - Table 76)** and based on trimester (second and third) **(Annexure 5- Table 78)**]. All the three parameters had very strong correlation with each other. Between Diameter and depth it was $r = 0.972$, $P < 0.01$, between diameter and shape there was strong negative correlation ($r = 0.935$, $P < 0.01$), between depth and shape there was strong negative correlation ($r = 0.964$, $P < 0.01$),

The correlation obtained when related to age were

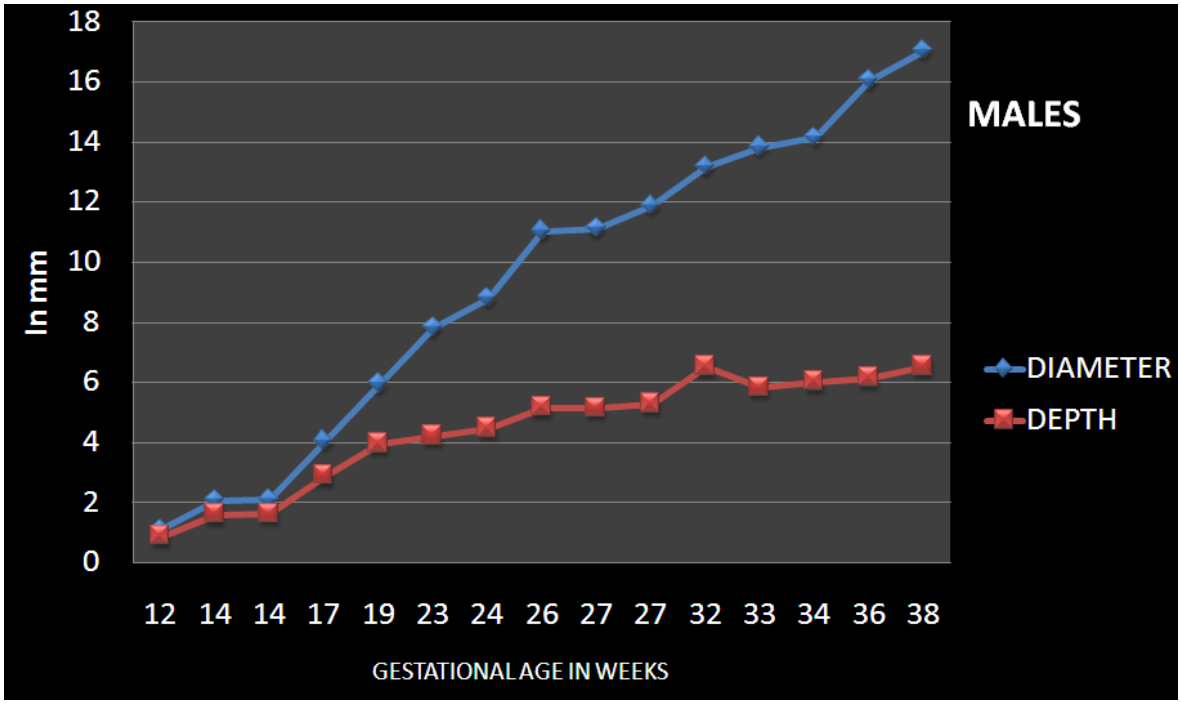
1) BASED ON WEEKS FROM 12 to 40 (12 to 20, 20 to 30, 30 to 40)

S.NO	PARAMETERS	r VALUE	P VALUE	CORRELATION
1.	DIAMETER	0.932	0.01	VERY STRONG
2.	DEPTH	0.882	0.01	VERY STRONG
3.	SHAPE	-0.893 (negative)	0.01	VERY STONG

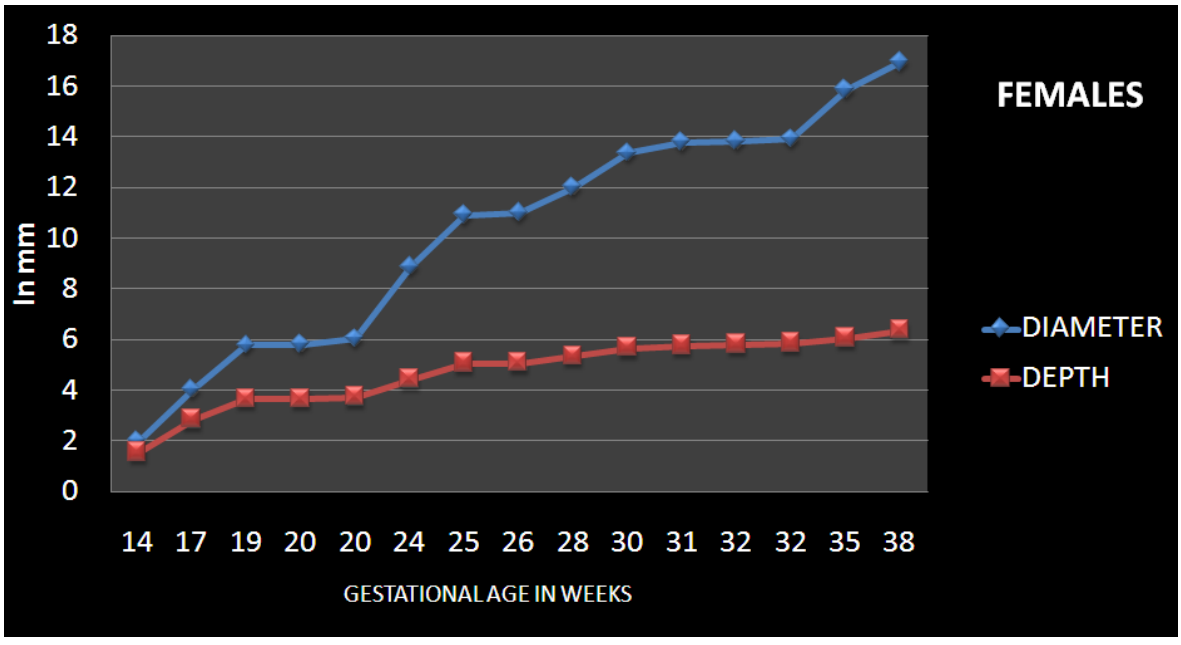
2) BASED ON TRIMESTER (BOTH SECOND AND THIRD)

S.NO	PARAMETERS	r VALUE	P VALUE	CORRELATION
1.	DIAMETER	0.863	0.01	VERY STRONG
2.	DEPTH	0.814	0.01	VERY STRONG
3.	SHAPE	-0.817 (negative)	0.01	VERY STONG

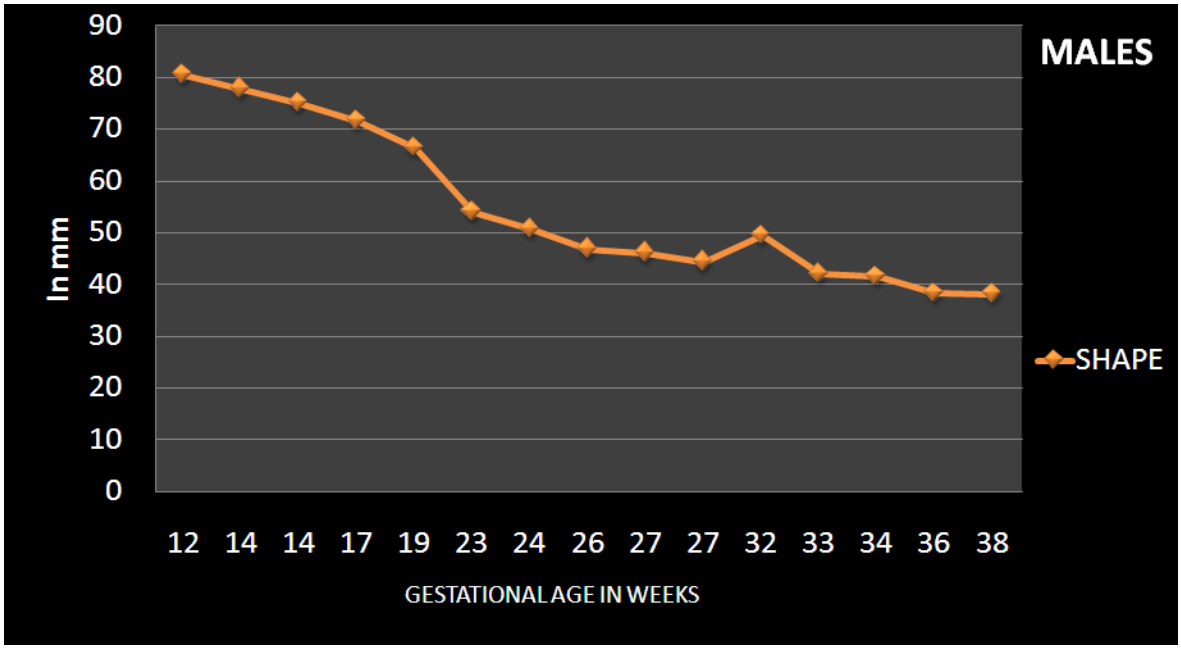
As a result as the age of fetus increases there is a significant increase in diameter and depth **(Graph 45 – 46)** as well as there is a significant decrease in the shape (**Graph 47 – 48)** of the acetabulum. **(Annexure 5 - Table 77, 79)**



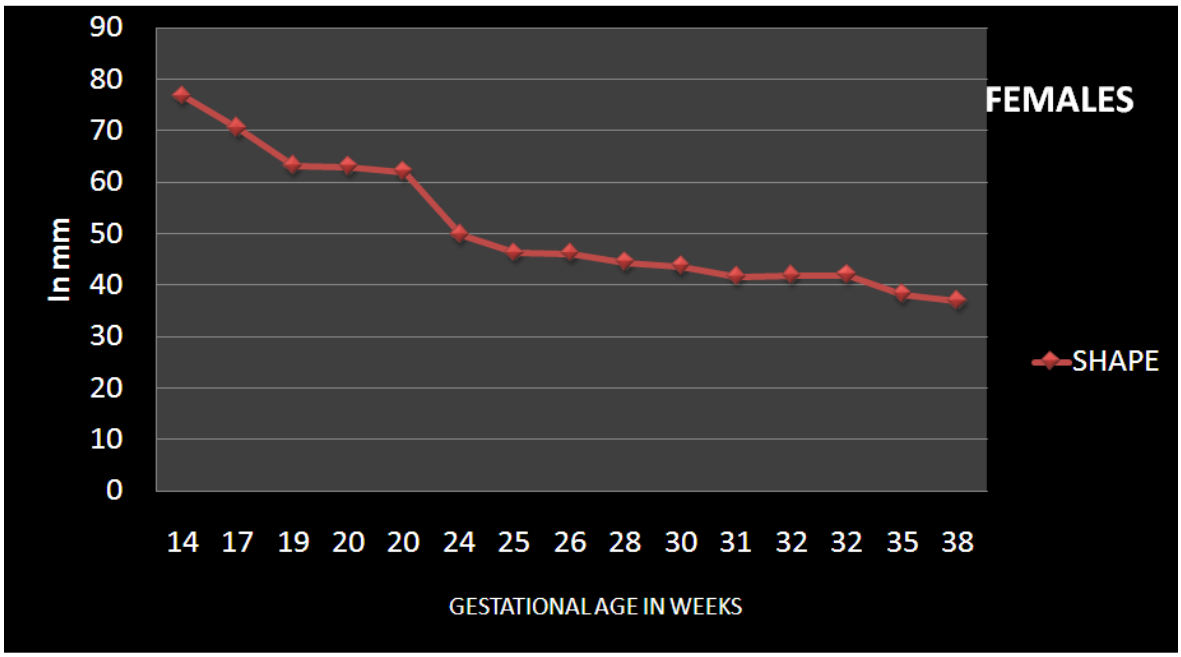
GRAPH 45 : PATTERN OF DIAMETER AND DEPTH WITH GESTATIONAL AGE IN MALES



GRAPH 46 : PATTERN OF DIAMETER AND DEPTH WITH GESTATIONAL AGE IN FEMALES



GRAPH 47 : PATTERN OF SHAPE WITH GESTATIONAL AGE IN MALES



GRAPH 48 : PATTERN OF SHAPE WITH GESTATIONAL AGE IN FEMALES

DISCUSSION

DRY ACETABULA

S.No	AUTHORS	DIAMETER	DEPTH	CAPACITY	ANTERIOR ACETABULAR RIDGE
1.	**Salamon A et al (2004)**	51.60 ± 3.8 (total)	30.00 ± 3.20 (total)		CURVED
2.	**Aksu T et al.(2006)**	54.29 ± 3.8 (total)	29.49 ± 4.20 (total)		
3.	**Maruyuma M et al (2010)**				CURVED
4.	**Gillard FC et al (june 2012)**				CURVED
5.	**Parmara Get al., (2013)**	49.23 ± 7.91 (total)	26.16 ± 7.69 (total)		
6.	**Vyas K(2013)**	47.90 (total right) 48.30 (total left)	27.10 (total right) 26.50 (total left)		CURVED
7.	**Dhindsa GS et al (2013)**	51.30 (total right) 50.03 (total left)	26.70 (total right) 26.40 (total left)	36.68 (total right) 33.56 (total left)	
8.	**Smitha M et al.(2013)**	51.87 (males) 47.23 (females)	27.46 (males) 26.15 (females)	30.48 (males) 26.87 (females)	
9.	**Devi TB et al (2014)**	50.99 ± 1.99 (total)	28.32 ± 1.32 (total)		CURVED
10.	**OUR STUDY**	48.55 ± 3.68 (total) 50.75 ± 2.69 (males) 46.07 ± 3.02 (females) 49.07 ± 3.55 (total right) 48.16 ± 3.77 (total left)	22.94 ± 2.91 (total) 24.30 ± 2.67 (males) 21.42 ± 2.39 (females) 22.58 ± 2.91 (total right) 23.26 ± 2.91 (total left)	31.10 ± 11.02 (total) 36.21 ± 11.47 (males) 25.34 ± 6.98 (females) 31.28 ± 9.16 (total right) 30.95 ± 12.47 (total left)	CURVED

Table 80 : comparative analysis of dry acetabular parameters between our study group and other reference studies

CADAVERIC ACETABULA

S.NO	AUTHORS	DIAMETER	DEPTH
1.	**Chauhan R et al (2002)**	47.10 ± 2.90 (right males) 47.48 ± 3.05 (left males) 44.38 ± 3.01 (right females) 46.00 ± 2.28 (left females)	27.49 ± 2.70 (right males) 28.18 ± 2.58 (left males) 24.68 ± 1.20 (right females) 25.70 ± 2.11 (left females)
2.	**Varma L et al (2010)**	45.31 (total males) 40.43 (total females)	28.26 (total males) 26.91 (total females)
3.	**Patel J et al (may,2013)**	45.42 ± 2.80 (right males) 45.07 ± 2.43 (left males) 41.76 ± 2.28 (right females) 41.98 ± 2.32 (left females)	29.96±2.96 (right males) 30.37 ±2.52 (left males) 27.44± 2.71 (right females) 27.57 ± 2.63(left females)
4.	**Varma L (july 2013)**	45.38 (right males) 45.54 (left males) 40.47 (right females) 40.18 (left females)	28.09 (right males) 28.49 (left males) 27.12 (right females) 26.77 (left females)
5.	**Prasath A et al (2014)**	45.14 ± 2.87 (right males) 45.20 ± 2.85 (left males) 41.09 ± 1.95 (right females) 39.93 ± 2.97 (left females)	29.79 ± 2.92 (right males) 30.09 ± 2.56 (left males) 28.74 ± 2.42 (right females) 27.97 ± 2.03 (left females)
6.	**OUR STUDY**	44.44 ± 2.83 (total males) 40.35 ± 2.68 (total females) 43.67 ± 3.41 (right males) 45.32 ± 1.84 (left males) 39.77 ± 2.60 (right females) 41.01 ± 2.82 (left females)	30.77 ± 3.23 (total males) 27.79 ± 2.29 (total females) 31.11 ± 4.10 (right males) 30.39 ± 2.13 (left males) 27.44 ± 1.80 (right females) 28.20 ± 2.84 (left females)

Table 81 : comparative analysis of cadaveric acetabular parameters between our study group and other reference studies

S.NO	PARAMETERS	GROUPS	Han CD et al (august,1998)	Umer M et al (2006)	GS Oladipo et al (2010)	Jeremic D et al. (2011)	OUR STUDY
1.	Centre edge angle. (CE angle)˚	Total Total males Total females	 32.60 ± 5.70 32.30 ± 6.80	31.25 ± 7.98	32.43±7.74	33.50 ± 6.50 33.60 ± 5.80 33.30 ± 6.90	42.40 ± 2.83 42.89 ± 3.02 41.91 ± 2.52
2.	Acetabular depth. (AD) mm	Total Total males Total females	 11.50 ± 2.60 10.20 ± 2.60			11.90 ± 2.80 12.50 ± 2.70 11.20 ± 2.70	20.88 ± 2.42 21.92 ± 2.61 19.84 ± 1.67
3.	Acetabular angle of Sharp.(AA) ˚	Total Total males Total females	 36.50 ± 3.50 37.50 ± 3.80	39.46 ± 6.04	35.47± 4.11	38.30 ± 3.60 37.50 ± 3.60 38.50 ± 3.90	36.25 ± 3.10 36.06 ± 2.06 36.25 ± 3.24
4.	Acetabular roof obliquity.(ARO) ˚	Total Total males Total females	 05.20 ± 4.80 08.00 ± 5.90	7.86 ± 6.55	15.80 ± 8.72	7.60 ±5.7 6.20 ± 4.9 9.00 ± 6.0	9.67 ± 1.90 9.69 ± 2.07 9.64 ± 1.72
5.	Acetabular index angle.(AIA) ˚	Total Total males Total females					24.99 ± 3.66 24.91 ± 4.09 25.08 ± 3.18
6.	Roof angle.(RA) ˚	Total Total males Total females	 18.60 ± 8.40 16.10 ± 9.40				18.74 ± 2.09 19.55 ± 2.00 17.91 ± 1.84
7.	Depth to width ratio.(DTW)	Total Total males Total females		0.32 ± 0.06	0.38 ± 0.04		0.32 ± 0.04 0.32 ± 0.03 0.32 ± 0.04
8.	Extrusion index.(EI)	Total Total males Total females		0.18 ± 0.08	0.48 ± 0.003		0.12 ± 0.03 0.13 ± 0.02 0.12 ± 0.22
9.	Lateral subluxation.(LS) mm	Total Total males Total females		9.90 ± 2.71	4.12 ± 1.27		7.85 ± 1.44 7.85 ± 1.44 7.34 ± 1.36
10.	Peak to edge distance.(PED) Mm	Total Total males Total females		15.65 ± 3.04	6.35 ± 1.58		18.47 ± 2.69 19.26 ± 2.49 17.64 ± 2.65
11.	Joint space width (JSW) mm	Total Total males Total females					7.98 ± 1.24 8.30 ± 1.35 7.66 ± 1.02

Table 82 : comparative analysis of Acetabular parameters in X rays between our study group and other reference studies

1.DRY ACETABULA:

Aksu T et al. (2006) on observing 154 hip bones of both the sexes in Turkey population, reported that the anterior acetabular ridge's morphology was curved in 71(46.1%), straight in 36 (23.3) ,angular in 26(16.8%) and irregular in 21 (13.6%). He took the acetabular diameter as the distance between the acetabular ridge which is near to the ischial body and anterior iliac margin getting intersected with acetabular ridge.In our study we observed, total of 100 dry hip bones. As far as methodology is concerned we differed for measuring the diameter of the acetabulum from the above study, because we took the greatest transverse diameter as the diameter of the acetabulum but for the depth we adhered to their method, the slight difference is that the horizontal scale is placed across the diameter of the acetabulum. We also looked for the morphology of anterior acetabular ridge. The results of our study and the reference study were documented in **Table 80**.

On comparing the results, both the depth as well as the lowest range of the diameter of our population were less than that of reference population. The maximum limit of the acetabular diameter immerse within the range of the reference population. The difference in the depth and the lowest range of acetabular diameter may be due to the ethnic difference between the races.The distribution of the anterior acetabular ridge was, 50 curved (50 %), 13 straight (13%), 17 angular (17%), 20 irregular (20 %). In the above study curved type and the irregular type were the most and least represented types where as in our study curved and straight were the most commonly and least commonly observed types. By pearson's correlation test the reference study

investigators observed a significant moderate positive correlation between the diameter and the depth, we second them with the same observation statistically.

Maruyuma et al (2010) on observing the 100 dry hip bones in Japan population and **Gillard FC et al (june 2012)** on observing 24 dry hip bones of both the sexes revealed that the curved type of anterior acetabular ridge was the most commonest type in their study population. As an adjunct to the above studies, we also find in our study that, the curved anterior acetabular ridge was the commonest one.

Smitha M et al. (2013) describes in her findings on observing dry acetabula that the curved anterior acetabular ridge is the most common type, we do observed the same.

Vyas K et al (2013) states , that in his observed 152 dry hip bones of unknown sex and age belonging to Baroda population, curved (C) anterior acetabular rim was found in 57(37.5%), straight (S) shaped was found in 48(31.6%), irregular (I) shaped in 28(18.4%) and angular (A) shaped in 19(12.5%).In our study, we paralleled with the the above methodology of observing the anterior acetabular ridge, diameter of the acetabulum and the depth of the acetabulum but the material was about 100 dry hip bones. On observing our result and the result of **Vyas K et al (Table 80)**,the diameter on right was more in our study, but it was more on left in their study. The depth on both the sides was less when compared to the reference population. The distribution of the anterior acetabular ridge also differed that we ve got 50 % of curved, 13 % of straight, 17 % of angular and 20% of irregular. The order of types in reference were

C > S > I > A, in ours the order was C > I > A > S.

Inspite of same methodologies followed, genetic traits would have played a significant role in bringing the difference in measurements.

Devi TB et al (2014) did a study in Sikkim , Pondicherry population by including 100 dry bones from both the institutes (50 males , 50 females). They examined the diameter and depth of the acetabulum in both the population. They analysed the depth , diameter and anterior acetabular ridge morphology of the acetabulum to signify its importance during acetabular cup placing in hip arthroplasty surgeries. They took the the distance between point on anterior ridge nearest to the body of the ischium and the point of anterior iliac margin intersecting the acetabular ridge. (using digital vernier caliper).The measurement got was kept as the diameter of the acetabulum. The depth was found as per Tastekin aksu methodology .Positive and significant correlation was obtained between diameter and depth of the population.($p < 0.001$). In our study we examined 100 dry hip bones (acetabula) , in the results, the lowest range of the diameter was low in our study population whereas the highest limit falls within the reference range. **(Table 80)** .The mean acetabular depth of the reference population was higher than our study population. The difference in the methodology of the diameter assessment between the two population would have brought the difference in measurements .Statistically there was a significant positive correlation between the dimeter and depth of acetabulum in reference population, we do observe the same.

2)CADAVERIC ACETABULA

Chauhan R et al. (2002) studied 54 cadaveric hip joints in North Indian hip joints. In our study, we studied 30 cadaveric hip joints in the South Indian hip joints , we proceeded with the measurements of the acetabular diameter and depth as same as that of the above study and observed the results as in **Table 81**. From the above results, when we compare our result with reference, it was observed that in our study population the depth is more both in males and in females where as the diameter is less in females, when compared to the reference population. The acetabular diameter of the males in study group lies within the range of reference population. Statistically comparing, in the reference study only there was significance in right side of males and females whereas in our study both the subgroups like right side of males, females and left side of males, females were statistically significant. We adhere firmly with the above study that only gender difference is significant and not the sidedness.

According to **Varma L et al (2010)**, in her study in Bangalore population , revealed that there was significant difference in gender but not with the side with respect to both diameter and depth of the acetabulum. The results of her study was compared with ours in **Table 81** and the observation was: In our population , the mean diameter was less when compared to reference population and the mean depth was more when compared to reference population.In statistics we adhere with the reference study that, there was significant difference in gender but not with the side.

Patel J et al. (may,2013) in the study over surat population , observed 50 cadaveric hip joints (males 30 ,15 right and 15 left,females 20 ,10 right and 10 left)

the mean depth of acetabulum was 29.96±2.96 (males, right side) In our study , we studied 30 cadaveric hip joints (15 males , 15 females and 16 right and 14 left) over the South Indian popualtion, we proceeded with the measurements of the acetabular diameter and depth , as same as that of the above study. From the above two studies results **(Table 81)** it is observed that in our population also the left sided values predominated the right sided values in both the sexes. No statistical significance was found between the gender and the side in reference population whereas in our study there was gender significance but there was no significance in sides.

Varma L et al (july 2013) conducted a study in bangalore population and among 60 human cadavers , he analyzed the diameter and the depth of the acetabulum. Males had greater measurements than females on all aspects**(Table 81).** We studied 30 cadaveric hip joints (15 males , 15 females and 16 right and 14 left) in South Indian population, we adhered with the methodology of measurements of the acetabular diameter and depth as same as that of the above study .Among all the parameters , the left side acetabular diameter of the females was more when compared with the reference population , rest all in the reference population were more than our population. In statistics we rely with the reference study that, there was significant difference in gender but not with the side.

Prasath A et al (2014) did a cadaveric morphometric analysis of acetabulum and femoral head in both the sexes of south Indian human cadavers. He dissected out 100 adult human cadavers (70 males , 30 females) and measured the diameter of the head of femur , acetabular diameter and the depth of the acetabulum. Gross outcome was that the measurements of the paramenters in the males were greater than that of

the females **(Table 81).**In our study , we also studied 30 cadaveric hip joints (15 males , 15 females and 16 right and 14 left) in South Indian population , we proceeded with the measurements of the acetabular diameter and depth as same as that of the above study and observed that the measurements of both the study and the reference population lies within the same range. On comparing with the above study , the left side acetabular diameter of males , females and left side depth of the acetabulum were less than that of the reference population. Statistical analysis in the reference study shows that there is a significant difference of observed parameters with gender and not with side; we do affirmatively observe the same statistical results.

3) RADIOLOGICAL ASSESSMENT OF ACETABULA (X RAYS)

Yoshimura N et al.(july,1998) conducted studies in Japan and Britain (1303 men , 195 women) prospectively by obtaining plain normal Xrays of pelvis AP views.The mean CE angle among men in britain was 36° and in japan was 31° , among females in britain was 37° degrees and 31° in japan , the mean values of acetabular depth were 9.2 mm in males,8.9 mm in females in japan in Britain were 14.4 mm in males,14.1in females. In our study population, the mean acetabular diameter in males and females was 42.89 ± 3.02, 41.91 ± 2.52 respectively. The mean acetabular depth in males and females was 21.92 ± 2.61 and 19.84 ± 1.67 respectively. Both the mean diameter and depth in our study population were more than the reference population in Britain and Japan.

Han CD et al.(august,1998) observed CE angle, AD , AA , ARO and RA in 591 normal adult hips (normal X rays of pelvis AP views) prospectively. In our study on reading 105 xrays retrospectively that is 210 acetabula, we also observed the parameters and the results were compared (**Table 82**). On comparing the results , the CE angle and acetabular depth range were more in our study population than the reference population but the acetabular angle, acetabular roof obliquity , roof angle of the study group falls within the range of the reference population. On statistical analysis they did not find CE angle as a significant parameter towards gender but in our study we found it very significant with gender. Affirmative with their study we find that the rest of the parameters observed were statistically significant towards gender and all the parameters were not significant towards the side of the acetabula.

Umer M et al (2006), on observing 522 normal X rays (pelvis AP) in Pakistan population described CE angle, AA, DTW, ARO, EI, LS and PED. In our study on

reading 105 xrays that is 210 acetabula totally, we documented the results and compared it with the reference study.(**Table 82**).Statistically they concluded that CE angle as most significant diagnostic indicator of acetabular dysplasia. CE angle correlated stongly with AA, ARO, EI, PED. Significant difference was seen in gender, between the CE angle and EI. As a supplement to the above we also found CE angle as a significant marker in the normal X rays and also CE angle had positive correlation with PED but not with AA,ARO and EI instead we had positive correlation with LS.Age acted as a confounding variable on accounting to EI and AA.($P< 0.05$). Being representing the same subcontinent ; the built and the topography would have resulted in the difference in values.

Moussa M et al(march 2007) in the Saudi population, after examining 104(55 males , 49 females) normal pelvic radiographs of the patient (aged over 40) who came for intravenous pyelogram, he described the CE angle and AA.By comparing the means it was obvious that the acetabular angle in the reference population and the study population were within the same range. Rest of the parameters in toto were supremed by the study group.(**Table 82**). In the reference study there was statistically a gender significance for CE angle , we also had it , for them there was a negative correlation between CE angle and AA where as there was no correlation in our study, they had no significant difference between right and left hips, we also abide by them. Age had no relation to CE angle and AA.

The mean AA, CE angle, AV, AD were 39.2, 32.7, 18.2, 2.5 cm respectively as measured by **Saikia KC et al(2008)** . He observed 104 normal hip joint in the north eastern population of India. In our population the average AA, CE angle and AD were

36.25 , 42.40 and 20.88 . By comparing the means of all the three, the AA was more in the reference population , CE angle and AD were more in our study population. AV was not entitled in our X ray perimetry , in CT was around 20.97 ± 4.55.

Joint space width (superolateral , superomedial) was examined by **Im GI et al(2009)** in Korean population. 428 patients who had normal pelvic X rays were recruited and the joint space width was evaluated; superolaterally the mean with SD was 4.88± 0.99 and superomedially the value was 4.69 ± 1.04. CE angle had inverse correlation with JSW. We measured the JSW by taking the measurements at the level of Through fovea of the femoral head , Lateral limbus of the acetabulum, Lower part of acetabulum.(near the inferior tip of the tear drop.) The mean JSW was 7.98 ± 1.24. The difference in methodology brought the difference in measurements and also , we did not have inverse correlation between the CE angle and JSW.

Oladipo GS et al (2010) observed CE angle, AA, DTW, ARO, EI, LS, PED in the Nigerian population of both males and females and the results of his and our study comprising the the same parameters by observing 210 acetabula (106 males and 104 females) were tabulated in **Table 82**.In the reference study CE angle is the significant parameter and it also has a strong correlation with AA, LS, and PED. In our study also CE angle is one of the significant parameter with positive correlation to LS and PED but not with AA.

Jeremic D et al. (2011) analyzed the AA, CE angle, AD, ARO in 370 X rays AP VIEW of Serbian population.CE angle and AA has no significant difference in age. CE angle has no significant difference related to gender. In our study on

analyzing 105 X rays in South indian population, the maximum value of CE angle, ARO and the AA of the reference population falls within the range of the study group with respect to all subdivided groups. AD measurements were higher in the study population (**Table 82**). In SPSS statistics analysis, in the reference study there was significant positive correlation with AD for CE angle but no relation with AA and ARO. In our study there was no relation between CE angle and AA, AD and ARO.

Park JM and Im GI (2011) in a study conducted over four hundred and twenty eight consecutive korean patients with no evidence of hip osteoarthritis , AP radiographs of pelvis were taken and the mean CE angle was 37.9 °± 5.6 ° ,the mean AD was 11.6 ± 2.7 mm and the mean AA was 38.1°± 4.2 °. There was a significant direct relation between age with CE angle and inversely proportional relation between age with AA and AD. The mean AA, CE angle, AD in our study were 38.65 ± 2.77, 43.09 ± 4.33 , 19.19 ± 2.77. In our study over 105 South Indian patients, the mean values of AA, CE angle lies in range with the reference population whereas the AD was more than that of the reference population. CE angle was significant but had no relation with AA and AD.

Inspite of adhering to the same methodology as kept in the reference studies for measuring the Acetabular parameters, we observed difference in measurements, may be due to the difference in genetic and geographical distribution of the various population.

CT ACETABULA:

CE angle , AA , AV , AD , JSW ,AASA and PASA were observed by **Baharuddin MY et al.(december 2011)** after examining 120 Acetabula (CT)in 60 malay subjects, we observed same parameters in 100 (CT) acetabula in the South Indian population . The right and left sided differences of males and females , in the reference study and in our study were documented in (**Table 83 a And 83 b**) respectively. On summation of all the parameters, the AA and AV of the reference population was more than that of our study population.

	REFERENCE STUDY Baharuddin MY et al.(december 2011)			OUR STUDY	
S.NO	**PARAMETERS**	**RIGHT**	**LEFT**	**RIGHT**	**LEFT**
1.	CE angle	29.32±5.60	32.10±4.84	42.70 ± 4.30	42.35 ± 3.92
2.	AIA	9.56±3.58	10.19±4.10	27.25 ± 5.18	25.98 ± 5.04
3.	AA	42.96±3.37	42.87±3.05	39.42 ± 2.47	39.31 ± 2.34
4.	AV	42.96±3.37	42.87±3.05	21.14 ± 4.64	22.22 ± 4.34
5.	AD	15.29±5.04	15.06±4.35	18.43 ± 3.08	17.98 ± 2.47
6.	JSW	5.81±0.72	5.64±0.76	6.72 ± 0.77	6.35 ± 0.82
7.	AASA	59.40±7.72	60.75±5.62	69.53 ± 10.53	68.19 ± 5.83
8.	PASA	92.26±6.54	93.46±6.19	106.93± 9.73	109.76 ± 7.15

(Table 83 a : comparison of acetabular parameters of males in CT)

	REFERENCE STUDY Baharuddin MY et al.(december 2011)			OUR STUDY	
S.NO	**PARAMETERS**	**RIGHT**	**LEFT**	**RIGHT**	**LEFT**
1.	CE angle	32.71±5.26	32.64±5.72	43.31 ± 4.36	42.87 ± 4.33
2.	AIA	9.42±3.69	10.64±4.76	25.56 ± 5.04	25.69 ± 4.80
3.	AA	42.05±3.4	41.52±3.08	38.80 ± 2.83	38.49 ± 2.72
4.	AV	42.96±3.37	42.87±3.05	20.46 ± 4.83	21.47 ± 4.47
5.	AD	16.05±1.75	16.29±1.24	19.34 ± 2.89	19.04 ± 2.67
6.	JSW	5.99±0.76	5.93±0.95	7.15 ± 1.10	6.81 ± 1.06
7.	AASA	63.02±6.11	61.58±9.55	69.08 ± 8.59	68.97 ± 5.96
8.	PASA	92.75±6.58	92.73±6.01	105.72 ± 12.11	108.80 ± 9.29

(Table 83 b : comparison of acetabular parameters of females in CT)

Statistically analyzing, in the reference study CE angle was the significant parameter . In our study, we found that CE angle was insignificant. **Arsic S et al. (june 2013)** conducted a study in their serbian population(aged over 20 years), in which 58CT of acetabulum 0.5 mm thickness were analysed. In the results, the mean CE angle, AIA, AA, AD, JSW, AV, AASA, PASA were 47.19° ± 7.17°, 25.50° ± 5.3°,37.2° ± 5.14°, 24.16 ± 6.7, 4.99 ± 1.47, 23.62° ± 5.55°, 65.05°±12.15°, 114.52° ± 9.65° respectively. In males the mean CE angle, AIA, AA, AD, JSW, AV, AASA, PASA were 48.42°± 7.91° , 25.15° ± 5.18° , 36.14° ± 6.56° , 26.47 ± 7.73 , 4.78 ± 1.38 , 21.86° ± 5.54°, 68.72° ± 14.2°, 111.67 °± 6.57° respectively. In females mean CE angle, AIA, AA, AD, JSW, AV, AASA, PASA were 45.99° ± 6.27°, 25.83° ± 5.49°, 38.2° ± 3.11° , 22.01 ± 4.78, 4.96 ± 1.05, 25.26 ± 5.13°, 63.7 ± 10.55° , 115.25 ± 7.28° respectively. In our study we examined 100 ct acetabula : the mean CE angle, AIA, AA, AV, AD, JSW, AASA and PASA were 43.09 ± 4.33 ,26.11 ± 4.92, 38.65 ± 2.77, 26.11 ± 4.92, 19.19 ± 2.77, 6.98 ± 1.09, 69.02 ± 7.35 and 107.26 ± 10.85 respectively. In the reference study there was significant relation between AD and AV with CE angle but in our study the CE angle had no relation to AD and AV.

The difference in the observations may be due to difference in the genetical traits and the geographical distribution.

4)FETUS ACETABULA:Ralis Z et al (1973) dissected out 44 human hip joints (15 aborted fetuses, 29 dead children of various age groups ranging from eleven and a half weeks embryo to eleven year old child. Fetuses were measured using crown rump length and correlated with thegestational stage. The diameter, the depth and the shape of the acetabulum were assessed among different age groups with the help of marker

wires and vernier caliper.Morphometric assessment of development of the human fetal hip joint was done by **JM Walker et al (1981)** in 140 human fetuses (canada population) which were obtained from abortions during the perinatal period. The crown rump length of the fetuses was from 8.7 cm to 40 cm and the gestational weeks of the fetuses attributed to the study were between 12 and 42 weeks of age. The joint cavity was dissected out and in acetabular part diameter, depth, shape were measured. All the measurements were taken with the help of the dissecting microscope. In our study, we adopted the methodology of Ralis Z et al, the samples were taken from 12 to 40 weeks (30 fetuses out of which 15 were males and 15 were females) and we adhere affirmatively with the results of Ralis et al and JM Walker et al, stating that the diameter, depth increases with the age till birth and the shape of the acetabulum becomes less hemispherical with the advancement of age and at birth it becomes very shallow. We did not observe the measurements after birth as like of Ralis et al.

Uysal LL et al (2004) dissected 15 male and 15 female fetuses (Turkey population) which were aborted. 60 hip joints were observed after removing the muscles and the capsule attached, labrum was kept intact. The vertical, transverse diameter of the femur, the acetabular diameter, the acetabular depth and the femoral head's length, width were assessed. In our study, we followed the same sample size and same methodology except that we observed only the acetabular diameter and depth and not others. As adjunct to the above study, we also observed that the diameter and depth increased with age. We also observed it statistically, which was very significant.

SUMMARY

Anatomical, evolutionary, Anthropological, Histopathological, Forensic, Orthopedic and Radiological significance of **Acetabulum** were analysed and the dissertation plot was designed based on the acetabulum. Review of literature was done and the materials and methodology were framed to execute an extensive coverage of acetabular parameters in various modalities of study approaches and study groups. The acetabulum in Dry hip bones , cadaveric hip bones, X ray pelvis, CT abdomen & pelvis and fetuses were analysed with appropriate parameters, as reviewed in reference literature. The results obtained were,

In **100 dry hip bones**, initially the sex was determined and among 53 males and 47 females (right 46, left54) the **acetabular diameter, acetabular depth, capacity of acetabulum and types of anterior acetabular ridge** were observed, documented and classified as total mean, males, females, right side of the males, left side of the males, right side of the females and left side of the females.On statistical analysis, there was significant difference observed in the morphometric parameters when it is based on gender, there was no significance when based on sides. All the three parameters correlate positively with each other.

In **30 cadaveric hip bones** (15 males and 15 females) (16 right, 14 females) the **acetabular diameter, acetabular depth and capacity of the acetabulum** were analysed as total mean, males, females, right side of the males, left side of the males, right side of the females and left side of the females. There was significant difference observed in the morphometric parameters when it is based on gender, there was no

significance when based on sides. All the three parameters correlate positively with each other. These results were statistically observed and recorded.

105 Xray pelvis (AP view) (210 acetabula) (53 males 52 females) the **CE angle, acetabular depth, acetabular angle, acetabular index angle, roof angle, acetabular roof obliquity, extrusion index, lateral subluxation, depth to width ratio, joint space width and peak to edge distance** were measured and described under different subgroups as total mean, males, females, right side of the males, left side of the males, right side of the females and left side of the females. CE angle, AD, RA, LS, PED and JSW were the parameters observed to have statistically significant difference with respect to gender but not with sides. Rest of the parameters neither had gender significance nor had side difference when statistically assessed. Correlation of the significant parameters were also observed and documented.

In **CT abdomen and pelvis (50)** (100 acetabula) (24 males , 26 females) (50 right and 50 left) **CE angle, acetabular depth, acetabular angle, acetabular index angle, roof angle, acetabular roof obliquity, extrusion index, lateral subluxation, depth to width ratio, joint space width, peak to edge distance, acetabular version, anterior acetabular sector angle and posterior acetabular sector angle** were measured and enumerated under the groups like total mean, males, females, right side of the males, left side of the males, right side of the females and left side of the females. When statistically analyzed AD, RA, AA, LS, PED and JSW were the parameters observed to have significant difference with respect to gender but not with sides. Rest of the parameters neither had gender significance nor had side difference

when statistically assessed. Observations were made on the Correlation of the significant parameters and documented.

In **30 (15 males and 15 females)** (15 right and 15 left) fetuses the **acetabular diameter, acetabular depth and shape of the acetabulum** were measured and analysed in two different categories, one based on weeks (from 12 to 40 weeks with interval of ten weeks), the other based on trimester (second and third trimester).The diameter and depth of the acetabulum increased with the age of the fetuses and the shape of the acetabulum became less hemispherical as the age advanced , thereby the socket was converted into a shallow cavity. The results were statistically apprehended.

The measurements of all the acetabular parameters in all the study approaches with their own groups and subgroups were revealed, compared and discussed with the previous pioneer studies and the difference in measurements were accounted with a presumed justification.

LIMITATIONS OF THE STUDY:

1) Sample size was based on time and resource constraint.
2) Dry and cadaveric acetabula were observed from different samples.
3) Retrospective study was carried out for X rays and CT measurements, which were obtained from different patients.
4) As the follow up of the fetus study, the study could not be extended after the child birth, due to resource constraint.

CONCLUSION

Thus the human acetabulum had been observed and its parameters were evaluated in dry hip bones, cadaveric hip bones, X ray pelvis, CT abdomen & pelvis and fetuses. The mean values had been derived and grouped under total, in males, in females, in right side, in left side, in right side of the males, in left side of the males, in right side of the females and in left side of the females. The results had been compared with different reference population and the measurements of our study population had been documented. The dfference in measurements may be due to genetic,geographical dversities among the study groups.

The measurements were emphasized for diagnostic purposes in orthopedics and radiology like congenital dislocation of hip, dysplastic dislocation of hip , cam and pincer type of impingements, acetabular dysplasia and osteoarthritis , interventional procedures in orthopedic surgeries involving acetabulum approaches and most importantly in pretemplating before the hip arthroplasty surgical procedures which encompases the radiological excellence too. The measurements are hoped to make a valuable tool for sex determination in forensic field and the anthropological pattern of human acetabulum can also be enumerated.

We are anticipating to collect the measurements of acetabulum from same cadaveric specimen made as a dry bone acetabular specimen ,x rays and CT pelvis of the same patient, to include the MRI study groups, to involve the third eye thereby avoiding intra observer variation and to increase the sample size of the study population which would increase the credibility of the study in the near future.

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1) STATISTICS OF DRY ACETABULAR MORPHOMETRIC PARAMETERS: **ANNEXURE 1**

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	Lower	Upper
Diameter	Equal variances assumed	1.079	.302	8.190	98	**.000**	4.67887	.57130	3.54515	5.81259
	Equal variances not assumed			8.133	92.815	**.000**	4.67887	.57533	3.53636	5.82138

Table 52 : Significance of diameter between males and females (p < 0.05)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	Lower	Upper
Depth	Equal variances assumed	.523	.471	5.644	98	**.000**	2.87926	.51015	1.86689	3.89163
	Equal variances not assumed			5.681	97.983	**.000**	2.87926	.50683	1.87347	3.88505

Table 53 : Significance of depth between males and females (p < 0.05)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df		Mean Difference	Std. Error Difference	Lower	Upper
Capacity	Equal variances assumed	4.058	.047	5.632	98	**Sig. (2-tailed)**	10.86652	1.92939	7.03772	14.69532
	Equal variances not assumed			5.791	87.243	**.000** **.000**	10.86652	1.87630	7.13732	14.59572

Table 54 : Significance of capacity between males and females (p < 0.05)

Multiple Comparisons

Dependent Variable:Diameter

	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	**1.00**	2.00	.15861	.79449	.842	-1.4184	1.7357
		3.00	4.90892*	.87945	.000	3.1632	6.6546
		4.00	4.66102*	.74976	.000	3.1728	6.1493
	2.00	1.00	-.15861	.79449	.842	-1.7357	1.4184
		3.00	4.75032*	.91268	.000	2.9387	6.5620
		4.00	4.50242*	.78847	.000	2.9373	6.0675
	3.00	1.00	-4.90892*	.87945	.000	-6.6546	-3.1632
		2.00	-4.75032*	.91268	.000	-6.5620	-2.9387
		4.00	-.24790	.87401	.777	-1.9828	1.4870
	4.00	1.00	-4.66102*	.74976	.000	-6.1493	-3.1728
		2.00	-4.50242*	.78847	.000	-6.0675	-2.9373
		3.00	.24790	.87401	.777	-1.4870	1.9828

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

Table 55 : Significance of diameter between different sub groups by One way ANOVA ($p < 0.05$)

Multiple Comparisons

Dependent Variable:Depth

	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	**1.00**	2.00	-1.09816	.68806	.114	-2.4639	.2676
		3.00	3.30400*	.76164	.000	1.7922	4.8158
		4.00	1.85951*	.64932	.005	.5706	3.1484
	2.00	1.00	1.09816	.68806	.114	-.2676	2.4639
		3.00	4.40216*	.79041	.000	2.8332	5.9711
		4.00	2.95767*	.68285	.000	1.6022	4.3131
	3.00	1.00	-3.30400*	.76164	.000	-4.8158	-1.7922
		2.00	-4.40216*	.79041	.000	-5.9711	-2.8332
		4.00	-1.44449	.75693	.059	-2.9470	.0580
	4.00	1.00	-1.85951*	.64932	.005	-3.1484	-.5706
		2.00	-2.95767*	.68285	.000	-4.3131	-1.6022
		3.00	1.44449	.75693	.059	-.0580	2.9470

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

Table 56 : Significance of depth between different sub groups by One way ANOVA ($p < 0.05$)

Multiple Comparisons

Dependent Variable:Capacity

	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	**1.00**	2.00	-2.33441	2.67247	.385	-7.6392	2.9704
		3.00	10.47870*	2.95825	.001	4.6066	16.3508
		4.00	9.43017*	2.52200	.000	4.4240	14.4363
	2.00	1.00	2.33441	2.67247	.385	-2.9704	7.6392
		3.00	12.81311*	3.07002	.000	6.7192	18.9071
		4.00	11.76458*	2.65222	.000	6.5000	17.0292
	3.00	1.00	-10.47870*	2.95825	.001	-16.3508	-4.6066
		2.00	-12.81311*	3.07002	.000	-18.9071	-6.7192
		4.00	-1.04853	2.93997	.722	-6.8843	4.7873
	4.00	1.00	-9.43017*	2.52200	.000	-14.4363	-4.4240
		2.00	-11.76458*	2.65222	.000	-17.0292	-6.5000
		3.00	1.04853	2.93997	.722	-4.7873	6.8843

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

Table 57 : Significance of capacity between different sub groups by One way ANOVA ($p < 0.05$)

Correlations

		Diameter	Depth	Capacity
Diameter	Pearson Correlation	1	.603**	.589**
	Sig. (2-tailed)		.000	.000
	N	100	100	100
Depth	Pearson Correlation	.603**	1	.536**
	Sig. (2-tailed)	.000		.000
	N	100	100	100
Capacity	Pearson Correlation	.589**	.536**	1
	Sig. (2-tailed)	.000	.000	
	N	100	100	100

****. Correlation is significant at the 0.01 level (2-tailed).**

Table 58 : Correlation of diameter depth and capacity by Pearson's correlation test

2) STATISTICS OF CADAVERIC ACETABULAR MORPHOMETRIC PARAMETERS: ANNEXURE 2

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	**Sig.(2-tailed)**	Mean Difference	Std. Error Difference	Lower	Upper
Diameter	Equal variances assumed	.018	.893	4.056	28	**.000**	4.08733	1.00770	2.02316	6.15151
	Equal variances not assumed			4.056	27.919	**.000**	4.08733	1.00770	2.02289	6.15178

Table 59 : Significance of diameter between males and females (p < 0.05)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	Lower	Upper
Depth	Equal variances assumed	2.110	.157	2.912	28	**.007**	2.97933	1.02321	.88338	5.07528
	Equal variances not assumed			2.912	25.191	**.007**	2.97933	1.02321	.87280	5.08586

Table 60 : Significance of depth between males and females (p < 0.05)

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	Lower	Upper
Capacity	Equal variances assumed	1.585	.218	5.139	28	**.000**	9.98333	1.94270	6.00389	13.96278
	Equal variances not assumed			5.139	26.310	**.000**	9.98333	1.94270	5.99234	13.97433

Table 61 : Significance of capacity between males and females (p < 0.05)

Multiple Comparisons

Dependent Variable:Diameter

	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	**1.00**	2.00	-1.65518	1.42596	.256	-4.5863	1.2759
		3.00	3.88875*	1.37761	.009	1.0570	6.7205
		4.00	2.65911	1.42596	.074	-.2720	5.5902
	2.00	1.00	1.65518	1.42596	.256	-1.2759	4.5863
		3.00	5.54393*	1.42596	.001	2.6128	8.4750
		4.00	4.31429*	1.47273	.007	1.2870	7.3415
	3.00	1.00	-3.88875*	1.37761	.009	-6.7205	-1.0570
		2.00	-5.54393*	1.42596	.001	-8.4750	-2.6128
		4.00	-1.22964	1.42596	.396	-4.1608	1.7015
	4.00	1.00	-2.65911	1.42596	.074	-5.5902	.2720
		2.00	-4.31429*	1.47273	.007	-7.3415	-1.2870
		3.00	1.22964	1.42596	.396	-1.7015	4.1608

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

Table 62 : Significance of diameter between different sub groups by One way ANOVA ($p < 0.05$)

Multiple Comparisons

Dependent Variable:Depth

	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	**1.00**	2.00	.71625	1.49104	.635	-2.3486	3.7811
		3.00	3.66750*	1.44048	.017	.7065	6.6285
		4.00	2.90911	1.49104	.062	-.1558	5.9740
	2.00	1.00	-.71625	1.49104	.635	-3.7811	2.3486
		3.00	2.95125	1.49104	.058	-.1136	6.0161
		4.00	2.19286	1.53994	.166	-.9725	5.3582
	3.00	1.00	-3.66750*	1.44048	.017	-6.6285	-.7065
		2.00	-2.95125	1.49104	.058	-6.0161	.1136
		4.00	-.75839	1.49104	.615	-3.8233	2.3065
	4.00	1.00	-2.90911	1.49104	.062	-5.9740	.1558
		2.00	-2.19286	1.53994	.166	-5.3582	.9725
		3.00	.75839	1.49104	.615	-2.3065	3.8233

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

Table 63 : Significance of depth between different sub groups by One way ANOVA ($p < 0.05$)

Multiple Comparisons

Dependent Variable:Capacity

	(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	**1.00**	2.00	1.08482	2.84920	.706	-4.7718	6.9414
		3.00	10.59375*	2.75258	.001	4.9357	16.2518
		4.00	10.37054*	2.84920	.001	4.5139	16.2271
	2.00	1.00	-1.08482	2.84920	.706	-6.9414	4.7718
		3.00	9.50893*	2.84920	.003	3.6523	15.3655
		4.00	9.28571*	2.94264	.004	3.2370	15.3344
	3.00	1.00	-10.59375*	2.75258	.001	-16.2518	-4.9357
		2.00	-9.50893*	2.84920	.003	-15.3655	-3.6523
		4.00	-.22321	2.84920	.938	-6.0798	5.6334
	4.00	1.00	-10.37054*	2.84920	.001	-16.2271	-4.5139
		2.00	-9.28571*	2.94264	.004	-15.3344	-3.2370
		3.00	.22321	2.84920	.938	-5.6334	6.0798

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

Table 64 : Significance of capacity between different sub groups by One way ANOVA ($p < 0.05$)

Correlations

		Diameter	Depth	Capacity
Diameter	Pearson Correlation	1	.406*	.511**
	Sig. (2-tailed)		.026	.004
	N	30	30	30
Depth	Pearson Correlation	.406*	1	.537**
	Sig. (2-tailed)	.026		.002
	N	30	30	30
Capacity	Pearson Correlation	.511**	.537**	1
	Sig. (2-tailed)	.004	.002	
	N	30	30	30

***. Correlation is significant at the 0.05 level (2-tailed).**

****. Correlation is significant at the 0.01 level (2-tailed).**

Table 65: Correlation of diameter depth and capacity by Pearson's correlation test

ANNEXURE 3

3) STATISTICS OF ACETABULAR MORPHOMETRIC PARAMETERS IN X RAYS :

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	Lower	Upper
CEA	Equal variances assumed	2.576	.110	2.561	208	**.011**	.98663	.38528	.22707	1.74618
	Equal variances not assumed			2.565	202.724	**.011**	.98663	.38462	.22827	1.74499
AD	Equal variances assumed	18.530	.000	6.869	208	**.000**	2.08394	.30339	1.48582	2.68205
	Equal variances not assumed			6.896	179.509	**.000**	2.08394	.30219	1.48764	2.68023
AA	Equal variances assumed	1.117	.292	-.917	208	.360	-.39245	.42802	-1.23627	.45137
	Equal variances not assumed			-.916	205.621	.361	-.39245	.42839	-1.23704	.45214
ARO	Equal variances assumed	2.377	.125	.216	208	.829	.05693	.26335	-.46225	.57612
	Equal variances not assumed			.217	202.569	.829	.05693	.26289	-.46143	.57529

AIA	Equal variances assumed	3.902	.050	-.327	208	.744	-.16562	.50675	-1.16465	.83341
	Equal variances not assumed			-.328	197.732	.744	-.16562	.50556	-1.16260	.83136
RA	Equal variances assumed	.641	.424	6.182	208	**.000**	1.64323	.26580	1.11923	2.16723
	Equal variances not assumed			6.187	207.275	**.000**	1.64323	.26560	1.11961	2.16685
DTW	Equal variances assumed	.743	.390	.172	208	.864	.00088	.00515	-.00926	.01103
	Equal variances not assumed			.171	194.802	.864	.00088	.00516	-.00929	.01105
EI	Equal variances assumed	.209	.648	1.832	208	.068	.00518	.00283	-.00039	.01075
	Equal variances not assumed			1.829	202.379	.069	.00518	.00283	-.00040	.01076
LS	Equal variances assumed	.116	.734	5.335	208	**.000**	.99901	.18724	.62987	1.36815
	Equal variances not assumed			5.335	207.827	**.000**	.99901	.18726	.62984	1.36818

PED	Equal variances assumed	.900	.344	4.569	208	**.000**	1.62013	.35462	.92103	2.31924
	Equal variances not assumed			4.566	206.564	**.000**	1.62013	.35484	.92057	2.31969
JSW	Equal variances assumed	7.603	.006	3.857	208	**.000**	.63978	.16585	.31280	.96675
	Equal variances not assumed			3.868	195.184	**.000**	.63978	.16542	.31354	.96602

Table 66 : Significance of Acetabular parameters between males and females ($p < 0.05$)

Multiple Comparisons

LSD

Dependent Variable	(I) GROUPS	(J) GROUPS	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
CEA	1.00	2.00	-.21698	.54465	.691	-1.2908	.8568
		3.00	.92141	.54726	.094	-.1575	2.0004
		4.00	.83487	.54726	.129	-.2441	1.9138
	2.00	1.00	.21698	.54465	.691	-.8568	1.2908
		3.00	1.13839*	.54726	.039	.0594	2.2173
		4.00	1.05185	.54726	.056	-.0271	2.1308
	3.00	1.00	-.92141	.54726	.094	-2.0004	.1575
		2.00	-1.13839*	.54726	.039	-2.2173	-.0594
		4.00	-.08654	.54986	.875	-1.1706	.9975
	4.00	1.00	-.83487	.54726	.129	-1.9138	.2441
		2.00	-1.05185	.54726	.056	-2.1308	.0271
		3.00	.08654	.54986	.875	-.9975	1.1706
AD	1.00	2.00	.14755	.42715	.730	-.6946	.9897
		3.00	1.87281*	.42920	.000	1.0266	2.7190
		4.00	2.44262*	.42920	.000	1.5964	3.2888
	2.00	1.00	-.14755	.42715	.730	-.9897	.6946
		3.00	1.72526*	.42920	.000	.8791	2.5714
		4.00	2.29507*	.42920	.000	1.4489	3.1413
	3.00	1.00	-1.87281*	.42920	.000	-2.7190	-1.0266
		2.00	-1.72526*	.42920	.000	-2.5714	-.8791
		4.00	.56981	.43124	.188	-.2804	1.4200
	4.00	1.00	-2.44262*	.42920	.000	-3.2888	-1.5964
		2.00	-2.29507*	.42920	.000	-3.1413	-1.4489
		3.00	-.56981	.43124	.188	-1.4200	.2804

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

RA	1.00	2.00	.69623	.37275	.063	-.0387	1.4311
		3.00	2.01923*	.37454	.000	1.2808	2.7576
KEY:		4.00	1.96346*	.37454	.000	1.2250	2.7019
	2.00	1.00	-.69623	.37275	.063	-1.4311	.0387
1 – RIGHT MALES		3.00	1.32300*	.37454	.001	.5846	2.0614
2 – LEFT MALES		4.00	1.26724*	.37454	.001	.5288	2.0057
	3.00	1.00	-2.01923*	.37454	.000	-2.7576	-1.2808
3 – RIGHT FEMALES		2.00	-1.32300*	.37454	.001	-2.0614	-.5846
		4.00	-.05577	.37632	.882	-.7977	.6862
4- LEFT FEMALES	4.00	1.00	-1.96346*	.37454	.000	-2.7019	-1.2250
		2.00	-1.26724*	.37454	.001	-2.0057	-.5288
		3.00	.05577	.37632	.882	-.6862	.7977
LS	1.00	2.00	.17736	.26422	.503	-.3436	.6983
		3.00	1.17980*	.26549	.000	.6564	1.7032
KEY:		4.00	.99557*	.26549	.000	.4722	1.5190
	2.00	1.00	-.17736	.26422	.503	-.6983	.3436
1 – RIGHT MALES		3.00	1.00245*	.26549	.000	.4790	1.5259
2 – LEFT MALES		4.00	.81821*	.26549	.002	.2948	1.3416
	3.00	1.00	-1.17980*	.26549	.000	-1.7032	-.6564
3 – RIGHT FEMALES		2.00	-1.00245*	.26549	.000	-1.5259	-.4790
		4.00	-.18423	.26675	.491	-.7101	.3417
4- LEFT FEMALES	4.00	1.00	-.99557*	.26549	.000	-1.5190	-.4722
		2.00	-.81821*	.26549	.002	-1.3416	-.2948
		3.00	.18423	.26675	.491	-.3417	.7101
PED	1.00	2.00	.79830	.49837	.111	-.1843	1.7809
		3.00	1.96178*	.50076	.000	.9745	2.9491
		4.00	2.07678*	.50076	.000	1.0895	3.0641

KEY: **1 – RIGHT MALES** **2 – LEFT MALES** **3 – RIGHT FEMALES** **4- LEFT FEMALES**	2.00	1.00	-.79830	.49837	.111	-1.7809	.1843
		3.00	1.16348*	.50076	.021	.1762	2.1508
		4.00	1.27848*	.50076	.011	.2912	2.2658
	3.00	1.00	-1.96178*	.50076	.000	-2.9491	-.9745
		2.00	-1.16348*	.50076	.021	-2.1508	-.1762
		4.00	.11500	.50314	.819	-.8770	1.1070
	4.00	1.00	-2.07678*	.50076	.000	-3.0641	-1.0895
		2.00	-1.27848*	.50076	.011	-2.2658	-.2912
		3.00	-.11500	.50314	.819	-1.1070	.8770
JSW	1.00	2.00	.31226	.23317	.182	-.1474	.7720
		3.00	.89235*	.23429	.000	.4304	1.3543
		4.00	.69947*	.23429	.003	.2375	1.1614
KEY: **1 – RIGHT MALES** **2 – LEFT MALES** **3 – RIGHT FEMALES** **4- LEFT FEMALES**	2.00	1.00	-.31226	.23317	.182	-.7720	.1474
		3.00	.58009*	.23429	.014	.1182	1.0420
		4.00	.38720	.23429	.100	-.0747	.8491
	3.00	1.00	-.89235*	.23429	.000	-1.3543	-.4304
		2.00	-.58009*	.23429	.014	-1.0420	-.1182
		4.00	-.19288	.23541	.414	-.6570	.2712
	4.00	1.00	-.69947*	.23429	.003	-1.1614	-.2375
		2.00	-.38720	.23429	.100	-.8491	.0747
		3.00	.19288	.23541	.414	-.2712	.6570

Correlations

		CEA	AD	AA	ARO	AIA	RA	DTW	EI	LS	PED	JSW
CEA	Pearson Correlation	1	.046	-.120	-.100	-.249**	.196**	-.064	.058	.214**	.168*	.091
	Sig. (2-tailed)		.503	.084	.148	.000	.004	.353	.405	.002	.015	.187
	N	210	210	210	210	210	210	210	210	210	210	210
AD	Pearson Correlation	.046	1	.057	.006	-.131	.121	.211**	-.045	.206**	.350**	.127
	Sig. (2-tailed)	.503		.411	.926	.058	.080	.002	.514	.003	.000	.066
	N	210	210	210	210	210	210	210	210	210	210	210
RA	Pearson Correlation	.196**	.121	-.014	.049	.153*	1	.223**	.182**	.126	.111	.097
	Sig. (2-tailed)	.004	.080	.845	.484	.026		.001	.008	.069	.109	.164
	N	210	210	210	210	210	210	210	210	210	210	210
LS	Pearson Correlation	.214**	.206**	.016	.054	.053	.126	.091	.000	1	.141*	.275**
	Sig. (2-tailed)	.002	.003	.822	.435	.441	.069	.191	.997		.041	.000
	N	210	210	210	210	210	210	210	210	210	210	210
PED	Pearson Correlation	.168*	.350**	-.001	.002	.032	.111	-.002	-.030	.141*	1	.039
	Sig. (2-tailed)	.015	.000	.988	.978	.646	.109	.981	.668	.041		.575
	N	210	210	210	210	210	210	210	210	210	210	210

JSW	Pearson Correlation	.091	.127	.004	.062	.063	.097	.017	-.072	.275**	.039	1
	Sig. (2-tailed)	.187	.066	.952	.369	.360	.164	.807	.300	.000	.575	
	N	210	210	210	210	210	210	210	210	210	210	210

****. Correlation is significant at the 0.01 level (2-tailed).**

***. Correlation is significant at the 0.05 level (2-tailed).**

Table 68 : Correlation between the significant Acetabular parameters with others by Pearson's correlation test

4) STATISTICS OF ACETABULAR MORPHOMETRIC PARAMETERS IN CT : **ANNEXURE 4**

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
CEA	Equal variances assumed	.913	.342	1.364	98	.176	1.17692	.86282	-.53532	2.88916
	Equal variances not assumed			1.358	94.644	.178	1.17692	.86659	-.54357	2.89741
AD	Equal variances assumed	1.304	.256	3.994	98	.000	2.06285	.51650	1.03788	3.08783
	Equal variances not assumed			4.020	97.314	.000	2.06285	.51309	1.04456	3.08115
AA	Equal variances assumed	3.068	.083	-2.813	98	.006	-1.50673	.53565	-2.56970	-.44376
	Equal variances not assumed			-2.791	91.032	.006	-1.50673	.53994	-2.57925	-.43421
ARO	Equal variances assumed	.015	.902	-.885	98	.379	-.56923	.64345	-1.84613	.70767
	Equal variances not assumed			-.884	97.119	.379	-.56923	.64382	-1.84702	.70855
AIA	Equal variances assumed	.203	.654	-1.070	98	.287	-1.05385	.98459	-3.00774	.90004
	Equal variances not assumed			-1.074	97.999	.286	-1.05385	.98152	-3.00165	.89396
RA	Equal variances assumed	.489	.486	5.984	98	.000	2.91683	.48742	1.94956	3.88409
	Equal variances not assumed			5.932	90.157	.000	2.91683	.49169	1.94001	3.89364

DTW	Equal variances assumed	3.256	.074	1.574	98	.119	.01284	.00815	-.00335	.02902
	Equal variances not assumed			1.594	92.978	.114	.01284	.00805	-.00316	.02883
EI	Equal variances assumed	.001	.970	-1.741	98	.085	-.01151	.00661	-.02463	.00161
	Equal variances not assumed			-1.733	94.557	.086	-.01151	.00664	-.02469	.00168
LS	Equal variances assumed	.196	.659	1.984	98	.050	.49643	.25023	-.00015	.99301
	Equal variances not assumed			1.990	98.000	.049	.49643	.24941	.00148	.99138
PED	Equal variances assumed	.013	.910	2.990	98	.004	1.45590	.48698	.48950	2.42230
	Equal variances not assumed			2.972	93.374	.004	1.45590	.48980	.48331	2.42848
AV	Equal variances assumed	1.034	.312	-1.642	98	.104	-1.48529	.90473	-3.28069	.31011
	Equal variances not assumed			-1.641	97.052	.104	-1.48529	.90538	-3.28221	.31163
JSW	Equal variances assumed	4.734	.032	4.635	98	.000	.92095	.19870	.52663	1.31526
	Equal variances not assumed			4.570	83.082	.000	.92095	.20152	.52014	1.32175
AASA	Equal variances assumed	3.433	.067	.227	98	.821	.33638	1.47899	-2.59863	3.27138
	Equal variances not assumed			.230	92.220	.818	.33638	1.45957	-2.56236	3.23511
PASA	Equal variances assumed	3.045	.084	-1.041	98	.300	-2.26074	2.17115	-6.56932	2.04785
	Equal variances not assumed			-1.025	80.890	.308	-2.26074	2.20522	-6.64852	2.12705

Table 71 : Significance of Acetabular parameters between males and females ($p < 0.05$)

Multiple Comparisons

Dependent Variable		(I) Groups	(J) Groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
AD	LSD	1.00	2.00	.14167	.75098	.851	-1.3490	1.6323
			3.00	1.90984*	.73640	.011	.4481	3.3716
			4.00	2.35753*	.73640	.002	.8958	3.8193
		2.00	1.00	-.14167	.75098	.851	-1.6323	1.3490
			3.00	1.76817*	.73640	.018	.3064	3.2299
			4.00	2.21587*	.73640	.003	.7541	3.6776
		3.00	1.00	-1.90984*	.73640	.011	-3.3716	-.4481
			2.00	-1.76817*	.73640	.018	-3.2299	-.3064
			4.00	.44769	.72152	.536	-.9845	1.8799
		4.00	1.00	-2.35753*	.73640	.002	-3.8193	-.8958
			2.00	-2.21587*	.73640	.003	-3.6776	-.7541
			3.00	-.44769	.72152	.536	-1.8799	.9845
AA	LSD	1.00	2.00	.55000	.77842	.482	-.9952	2.0952
			3.00	-1.28558	.76330	.095	-2.8007	.2296
			4.00	-1.17788	.76330	.126	-2.6930	.3373
		2.00	1.00	-.55000	.77842	.482	-2.0952	.9952
			3.00	-1.83558*	.76330	.018	-3.3507	-.3204
			4.00	-1.72788*	.76330	.026	-3.2430	-.2127
		3.00	1.00	1.28558	.76330	.095	-.2296	2.8007
			2.00	1.83558*	.76330	.018	.3204	3.3507
			4.00	.10769	.74788	.886	-1.3768	1.5922

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

KEY:

1 – RIGHT MALES

2 – LEFT MALES

3 – RIGHT FEMALES

4- LEFT FEMALES

		4.00	1.00	1.17788	.76330	.126	-.3373	2.6930
			2.00	1.72788*	.76330	.026	.2127	3.2430
			3.00	-.10769	.74788	.886	-1.5922	1.3768
RA	LSD	1.00	2.00	-.07917	.70961	.911	-1.4877	1.3294
			3.00	3.01378*	.69583	.000	1.6326	4.3950
KEY:			4.00	2.74071*	.69583	.000	1.3595	4.1219
		2.00	1.00	.07917	.70961	.911	-1.3294	1.4877
1 – RIGHT MALES			3.00	3.09295*	.69583	.000	1.7117	4.4742
2 – LEFT MALES			4.00	2.81987*	.69583	.000	1.4387	4.2011
		3.00	1.00	-3.01378*	.69583	.000	-4.3950	-1.6326
3 – RIGHT FEMALES			2.00	-3.09295*	.69583	.000	-4.4742	-1.7117
			4.00	-.27308	.68177	.690	-1.6264	1.0802
4- LEFT FEMALES		4.00	1.00	-2.74071*	.69583	.000	-4.1219	-1.3595
			2.00	-2.81987*	.69583	.000	-4.2011	-1.4387
			3.00	.27308	.68177	.690	-1.0802	1.6264
LS	LSD	1.00	2.00	.30375	.36286	.405	-.4165	1.0240
			3.00	.56292	.35581	.117	-.1434	1.2692
KEY:			4.00	.73369*	.35581	.042	.0274	1.4400
		2.00	1.00	-.30375	.36286	.405	-1.0240	.4165
1 – RIGHT MALES			3.00	.25917	.35581	.468	-.4471	.9654
2 – LEFT MALES			4.00	.42994	.35581	.230	-.2763	1.1362
		3.00	1.00	-.56292	.35581	.117	-1.2692	.1434
3 – RIGHT FEMALES			2.00	-.25917	.35581	.468	-.9654	.4471
			4.00	.17077	.34862	.625	-.5212	.8628
4- LEFT FEMALES		4.00	1.00	-.73369*	.35581	.042	-1.4400	-.0274
			2.00	-.42994	.35581	.230	-1.1362	.2763

			3.00	-.17077	.34862	.625	-.8628	.5212
PED	LSD	1.00	2.00	.48750	.70616	.492	-.9142	1.8892
			3.00	1.46830*	.69244	.037	.0938	2.8428
KEY:			4.00	1.93099*	.69244	.006	.5565	3.3055
		2.00	1.00	-.48750	.70616	.492	-1.8892	.9142
1 – RIGHT MALES			3.00	.98080	.69244	.160	-.3937	2.3553
2 – LEFT MALES			4.00	1.44349*	.69244	.040	.0690	2.8180
		3.00	1.00	-1.46830*	.69244	.037	-2.8428	-.0938
3 – RIGHT FEMALES			2.00	-.98080	.69244	.160	-2.3553	.3937
			4.00	.46269	.67845	.497	-.8840	1.8094
4- LEFT FEMALES		4.00	1.00	-1.93099*	.69244	.006	-3.3055	-.5565
			2.00	-1.44349*	.69244	.040	-2.8180	-.0690
			3.00	-.46269	.67845	.497	-1.8094	.8840
JSW	LSD	1.00	2.00	.30958	.28500	.280	-.2561	.8753
			3.00	.88689*	.27947	.002	.3322	1.4416
KEY:			4.00	1.26458*	.27947	.000	.7098	1.8193
		2.00	1.00	-.30958	.28500	.280	-.8753	.2561
1 – RIGHT MALES			3.00	.57731*	.27947	.042	.0226	1.1320
2 – LEFT MALES			4.00	.95500*	.27947	.001	.4003	1.5097
		3.00	1.00	-.88689*	.27947	.002	-1.4416	-.3322
3 – RIGHT FEMALES			2.00	-.57731*	.27947	.042	-1.1320	-.0226
			4.00	.37769	.27382	.171	-.1658	.9212
4- LEFT FEMALES		4.00	1.00	-1.26458*	.27947	.000	-1.8193	-.7098
			2.00	-.95500*	.27947	.001	-1.5097	-.4003
			3.00	-.37769	.27382	.171	-.9212	.1658

Table 72 : Significant Acetabular parameters between the subgroups by One way ANOVA ($p < 0.05$)

Correlations

		CEA	AD	AA	ARO	AIA	RA	DTW	EI	LS	PED	AV	JSW	AASA	PASA
AD	Pearson Correlation	.367**	1	-.225*	-.290**	-.294**	.194	.763**	-.151	.033	.504**	-.090	.115	-.032	-.042
	Sig. (2-tailed)	.000		.024	.003	.003	.053	.000	.133	.744	.000	.375	.254	.754	.681
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
AA	Pearson Correlation	-.279**	-.225*	1	.303**	.241*	-.075	-.138	.241*	-.069	-.190	-.060	-.134	-.021	-.182
	Sig. (2-tailed)	.005	.024		.002	.016	.456	.172	.016	.497	.058	.555	.184	.834	.071
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
RA	Pearson Correlation	.159	.194	-.075	.057	-.003	1	.072	-.138	-.019	.120	.027	.101	-.052	-.135
	Sig. (2-tailed)	.115	.053	.456	.576	.973		.478	.172	.850	.234	.787	.316	.610	.181
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
LS	Pearson Correlation	-.136	.033	-.069	-.039	.075	-.019	-.068	-.252*	1	.323**	.038	.298**	-.103	-.141
	Sig. (2-tailed)	.178	.744	.497	.703	.457	.850	.500	.011		.001	.707	.003	.306	.161
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
PED	Pearson Correlation	.206*	.504**	-.190	-.232*	-.053	.120	.355**	-.361**	.323**	1	.130	.068	-.048	.117
	Sig. (2-tailed)	.039	.000	.058	.020	.601	.234	.000	.000	.001		.197	.502	.639	.247
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100
JSW	Pearson Correlation	-.190	.115	-.134	-.138	.002	.101	-.055	-.014	.298**	.068	-.113	1	-.225*	-.273**
	Sig. (2-tailed)	.058	.254	.184	.170	.986	.316	.584	.893	.003	.502	.263		.025	.006
	N	100	100	100	100	100	100	100	100	100	100	100	100	100	100

****. Correlation is significant at the 0.01 level (2-tailed).**

***. Correlation is significant at the 0.05 level (2-tailed).**

ANNEXURE 5

5) STATISTICS OF ACETABULAR MORPHOMETRIC PARAMETERS IN FETUSES :

Multiple Comparisons

LSD

Dependent Variable	(I) AGE	(J) AGE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
DIAMETER	1.00	2.00	-6.79250*	.52754	**.000**	-7.8489	-5.7361
1 – 12 TO 20 WEEKS		3.00	-10.97050*	.52754	**.000**	-12.0269	-9.9141
2 – 20 TO 30 WEEKS	2.00	1.00	6.79250*	.52754	**.000**	5.7361	7.8489
3 – 30 TO 40 WEEKS		3.00	-4.17800*	.52754	**.000**	-5.2344	-3.1216
	3.00	1.00	10.97050*	.52754	**.000**	9.9141	12.0269
		2.00	4.17800*	.52754	**.000**	3.1216	5.2344
DEPTH	1.00	2.00	-2.34600*	.22435	**.000**	-2.7953	-1.8967
1 – 12 TO 20 WEEKS		3.00	-3.44750*	.22435	**.000**	-3.8968	-2.9982
2 – 20 TO 30 WEEKS	2.00	1.00	2.34600*	.22435	**.000**	1.8967	2.7953
3 – 30 TO 40 WEEKS		3.00	-1.10150*	.22435	**.000**	-1.5508	-.6522
	3.00	1.00	3.44750*	.22435	**.000**	2.9982	3.8968
		2.00	1.10150*	.22435	**.000**	.6522	1.5508
SHAPE	1.00	2.00	23.40000*	1.48071	**.000**	20.4349	26.3651
1 – 12 TO 20 WEEKS		3.00	29.64400*	1.48071	**.000**	26.6789	32.6091
2 – 20 TO 30 WEEKS	2.00	1.00	-23.40000*	1.48071	**.000**	-26.3651	-20.4349
3 – 30 TO 40 WEEKS		3.00	6.24400*	1.48071	**.000**	3.2789	9.2091
	3.00	1.00	-29.64400*	1.48071	**.000**	-32.6091	-26.6789
		2.00	-6.24400*	1.48071	**.000**	-9.2091	-3.2789

***. The mean difference is significant at the 0.05 level.**

Table 76 : Significant Acetabular parameters between the subgroups by One way ANOVA (p < 0.05)

Correlations

		DIAMETER	DEPTH	SHAPE	AGE
DIAMETER	Pearson Correlation	1	.972**	-.975**	.932**
	Sig. (2-tailed)		.000	.000	.000
	N	60	60	60	60
DEPTH	Pearson Correlation	.972**	1	-.964**	.882**
	Sig. (2-tailed)	.000		.000	.000
	N	60	60	60	60
SHAPE	Pearson Correlation	-.975**	-.964**	1	-.893**
	Sig. (2-tailed)	.000	.000		.000
	N	60	60	60	60
AGE	Pearson Correlation	.932**	.882**	-.893**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	60	60	60	60

****. Correlation is significant at the 0.01 level (2-tailed).**

Table 77 : Correlation between the significant Acetabular parameters with others by Pearson's correlation test

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	**Sig. (2-tailed)**	Mean Difference	Std. Error Difference	Lower	Upper
DIAMETER	Equal variances assumed	6.009	.017	-13.007	58	**.000**	-8.31040	.63894	-9.58938	-7.03142
DEPTH	Equal variances assumed	34.990	.000	-10.667	58	**.000**	-2.60254	.24398	-3.09093	-2.11416
SHAPE	Equal variances assumed	35.043	.000	10.795	58	**.000**	22.19554	2.05612	18.07975	26.31132

Table 78: Significance of diameter , depth and shape between second and third trimester ($p < 0.05$)

Correlations

		DIAMETER	DEPTH	SHAPE	TRIMESTER
DIAMETER	Pearson Correlation	1	.972**	-.975**	.863**
	Sig. (2-tailed)		.000	.000	.000
	N	60	60	60	60
DEPTH	Pearson Correlation	.972**	1	-.964**	.814**
	Sig. (2-tailed)	.000		.000	.000
	N	60	60	60	60
SHAPE	Pearson Correlation	-.975**	-.964**	1	-.817**
	Sig. (2-tailed)	.000	.000		.000
	N	60	60	60	60
TRIMESTER	Pearson Correlation	.863**	.814**	-.817**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	60	60	60	60

**. Correlation is significant at the 0.01 level (2-tailed).

Table 79 : Correlation between the significant Acetabular parameters with others by Pearson's correlation test